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What Price Permanence?

. . . A long time ago, men believed it possible to build structures which would permanently defy time and depreciation. Some fifty to sixty centuries ago, in Egypt, a good deal of thought and energy was devoted to the problem; culminating in the Egyptian Pyramids, of which the Great Pyramid, tomb of Cheops, is probably the best known.

. . . Here, said the builders, is a structure that will defy the ravages of time for all eternity!

. . . The Great Pyramid still stands, after more than five thousand years; but not untouched by the ravages of time. With no factors of "use and occupancy," no roof, doors, windows, vibrating machinery; in fact, with nothing to contend with but a climate famous for its preservative qualities; yet this great structure long ago lost through disintegration and erosion its smooth outer coating, thereby reducing its base dimensions from an original 768 feet to 750 feet on each side. What stands today is not at all the original structure, but merely an artificially assembled pile of natural rock.

. . . Various attempts have been made to estimate the cost of this gigantic structure, but these vary widely. A single item in connection with the work, however, helps to a clearer perspective: the fact that the labor of 100,000 men was required for a period of ten years, merely to construct a causeway 3,000 feet long for transporting stone from the quarries.

. . . Here, on a comparatively minor project, was an expenditure of ten times 100,000 man-years of labor. Enough to supply a maintenance and repair crew of 100 men over a period of 10,000 years!

. . . This Great Pyramid stands as one of the wonders of the world. It stands as a monument to an ancient king's belief in the immortality of the human body. It stands, moreover, as an object lesson on the impermanence of man-made structures.

. . . Every building may be said to have a definitely limited expectation of life. From the moment of its completion, depreciation begins; wear and weather and the exigencies of use start right in to weaken and destroy it. Even if it were possible to build a structure proof against the ravages of time, it would not pay.

. . . It pays to design and build for "permanence," within limits, because such construction means much lower maintenance and repair cost, at a relatively slight increase in first cost. But the factors of prohibitive first cost and of probable obsolescence impose a limit in this direction.

. . . In the final analysis, the length of life and service of industrial buildings lies in the hands of the maintenance engineer. Neglect on his part means quick depreciation, expensive repair and replacements. This is true, whether the building was originally well built or badly built.

. . . The price of relative permanence, then, is intelligent, unremitting maintenance; keeping everlastingly a step ahead of the forces of disintegration; repairing the small defects before they grow big, and forestalling them.

SYSTEMATIC STRUCTURAL

Keeps a Step Ahead of Depreciation

The length of service of industrial buildings is largely a matter of intelligent maintenance.

SERVICE can be built into the roof in the first place; if not, it requires just that much more attention to upkeep and repair.

* * *

EFFICIENT maintenance of industrial structures and fixed plant differs considerably from the maintenance of production machinery. In the latter case, emergencies may arise at any moment, justifying emergency measures; synonymous, usually with costly measures. In the case of the structures and fixed equipment, emergencies are the exception when periodic inspection is maintained.

This very fact, however, tends to produce an attitude of comparative negligence which results in a rapid depreciation—or an exorbitant repair cost. In the case of production and auxiliary equipment, the production figures give a close check-up, day by day, of conditions from a maintenance standpoint. Only in the exceptionally well managed plant, however, is inspection so thorough as to give a similar check-up on the condition of the roofs, floors, walls, windows, and so on, which constitute the fixed plant and structures.

Accepted practice in modern accounting sets up a separate account through a yearly charge for depreciation, takes cognizance of the lessening value of these primary assets year by year. Conservative accounting usually sets this annual depreciation high, to retire the investment in a short term of years. Whatever the annual depreciation charge may be, it provides a yard stick of a sort, to measure the extent of such structural maintenance and repairs. It would, obviously, be poor economy to spend on such work more than the amount of money charged to depreciation; but it would be equally poor economy to permit, through neglect, an actual depreciation equal to or greater than the amount charged on the books.

As with all maintenance work, the keynote is the same: to prevent trouble before it can occur. Which means, first of all, a thorough, detailed knowledge of all parts of the plant; second, systematic inspection and scheduling of routine maintenance and repairs; third, and perhaps most important, intelligent supervision and planning.

When the construction of a new building is contemplated and the selection of site and type of building has been decided upon, thorough consideration should be given to the construction details, nature of materials and workmanship entering into the roofs, walls, floors and other parts of the building. The thoroughness with which this is done will determine the extent of the repairs necessary in the future. Each item should be considered from the standpoint of

MAINTENANCE *and* REPAIR

By L. E. DRIVER

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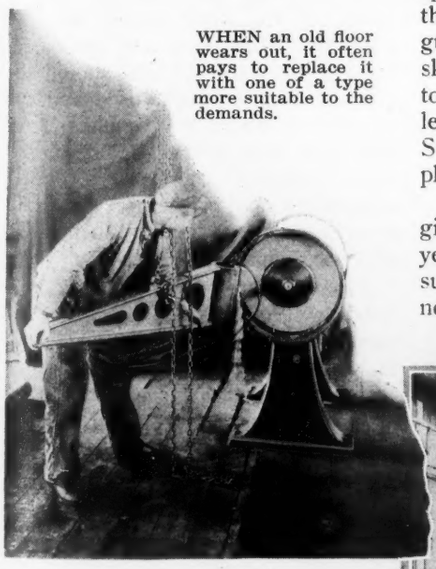
initial cost, service it will receive, ability to withstand wear and tear and the elements, and ultimate cost. In this manner the fact will be developed that low initial repairs in many instances will exceed the difference in initial cost. The purpose or use for which the building is built should also be taken into account when deciding upon selection of materials. This should mean that a new building should be easier and cheaper to maintain than an old one. However, there are many newer industrial buildings which cannot compare with the old ones in ruggedness and freedom from constant need for repairs. This fact is undoubtedly due to faulty construction or to the fact that proper thought was not given to the various items in the construction. Our modern engineering ideas and knowledge of materials certainly should enable us to construct better buildings than were built in former years.



WHEN an old floor wears out, it often pays to replace it with one of a type more suitable to the demands.

Roofs generally require extensive maintenance but if properly laid in the first place, are good for many years of service. It is, in fact, possible to obtain a roof with a guaranteed life of ten or twenty years. It is also possible to install a tin or other type of roof, and, by proper attention to maintenance, secure the same length of service. The choice, for the average plant's maintenance engineer, has already been made either by previous incumbents of his job or by the powers that be; and his province is confined to getting the best service out of whatever type of roof his buildings may be blessed or cursed with.

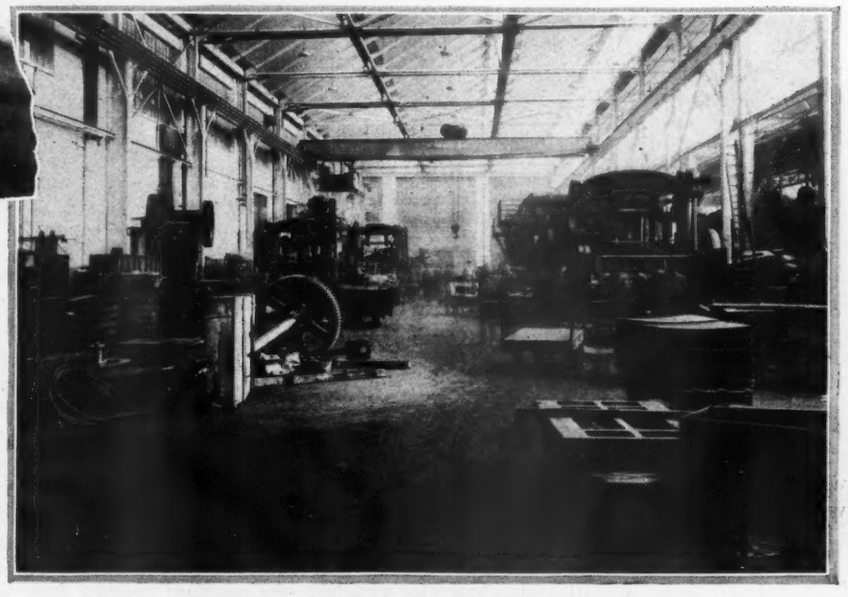
No matter whether slate, tar and gravel, asphalt, tin or some one of the many types of prepared roofing, it is good practice and common sense to arrange for routine inspection of the roofs on an average of once a month. Debris should be removed and any obstructions in gutters and downspouts should be promptly taken care of. The main body of the roof requires very little attention for months at a time, but the downspouts and gutters should be carefully inspected and special attention given to the flashings. The latter both at the gutters and around chimneys and skylights, have a constant tendency to develop cracks which, if neglected, lead to trouble in a very short while. Such cracks should be repaired with plastic tar compounds.

Tar and gravel roofs should be given a thorough examination once a year, preferably in the fall, to make sure that a new application of tar is not needed; either as a whole, or in spots. Tin roofs should be repainted at least every third year; even more often, when exposed to acid fumes or an excess of sulphurladen smoke.

Skylights, on which the metal is usually very thin, should be painted every year, and should be closely examined every fall for possible weak spots, before snow has a chance to pile up. It is a good plan to protect skylights by a heavy netting supported some 8 to 10 inches above the glass.

Brick or concrete buildings may be left unpainted, although in recent years there has been an increasing tendency toward the use of paint on concrete. This is because such practice waterproofs the concrete and seals up the minute cracks which, under severe weather conditions, would otherwise tend to expand and cause serious disintegration of the reinforcing steel. For applying paint to large wall areas, and especially of brick or concrete, the spray method is cheaper and as satisfactory as the brush method.

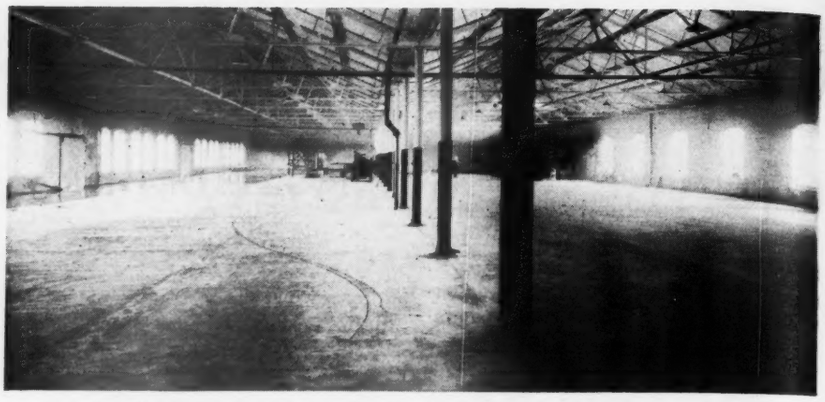
In the case of either brick or concrete, unpainted or painted, the time to repair cracks is when they first start, and before they have a chance to spread and become serious. Old brick walls require pointing of joints with cement mortar to prevent leak-



WOOD BLOCK, properly laid, meets the difficult conditions imposed here by heavy parts storage and trucking requirements.

age. Many so-called roof leaks can be attributed to seepage through old walls. Walls in old buildings should be plumbed as the walls can be tied and braced if necessary, so as to save replacement, if defect is found in time. In old buildings in which the walls act as bearing walls it is often found necessary to check the bearing or framing on walls. It is often found necessary to install corbels and columns and jury girders to support floors. This item is very important in old buildings and will prevent sagging of floors. In the case of wood walls, of course, painting at least every three years is the surest form of protection against too quick depreciation.

Whether the structure be wood, brick or concrete, the window casings and sash should be painted regularly, at least every three years. Puttying should be inspected at least once a year. In the case of sash subject to much handling, or exposed to severe weather or fume conditions, painting should be more frequent. Each fall, it is important to inspect the window casings and to see that there are no cracks for weather leakage at these points. Sometimes, frequent slamming of the window loosens the frames, especially at the sill. Such



CONCRETE FLOORS should be treated with one of the several hardening compounds, to prevent dusting and rapid wear under severe service.

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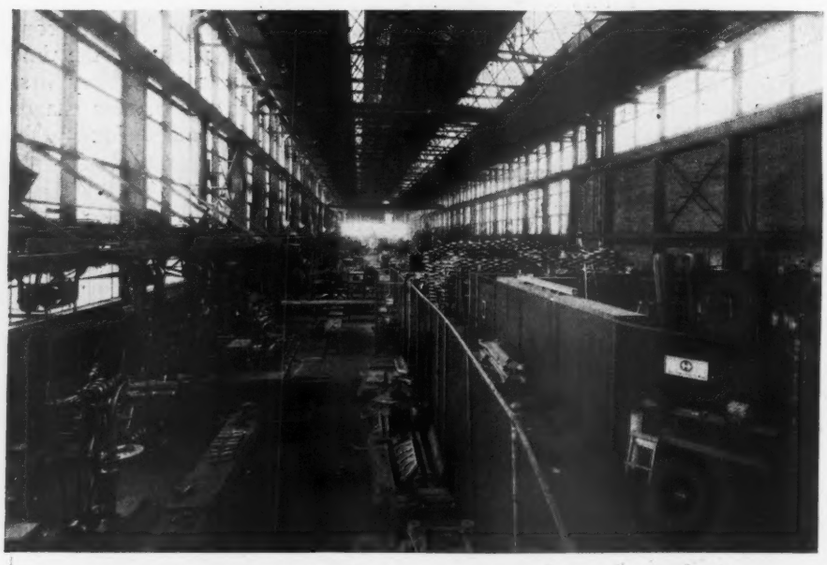
of proper thickness and grade and kept securely fastened to sash and well puttied. This will prevent most of the breakage except where the building is located in a section where boys have a tendency to exercise their arms in throwing stones. In this case it is a good plan to use wire glass on the first and second floors or protect the windows with screens.

Floors, whether of concrete, tongue-and-groove wood, wood block, or composition, are bound to wear. Where extensive repairs are found imperative, it is wise to make sure



WINDOWS, structural work, window casings and sash operating mechanism, roofs, floors—a thousand and one details, all must be constantly inspected and intelligently maintained, to keep ahead of depreciation.

* * *

places can be caulked and painted with roof cement. What applies to window casings, of course, applies also in the case of door casings.

It is often found that there is a high rate of breakage of individual panes of glass. All glass should be

whether it would pay to replace the old floor with one better suited to the particular conditions. Often such procedure, though it costs more to start with, more than saves its cost by avoiding the constant repairs that would be necessary in connection

with the old flooring. Concrete floors which tend to dust should be treated with one of the several concrete hardeners available. Where cracks or worn spots develop, the sooner they are repaired, the less expense will be involved.

Painting is a very important item and should be followed very carefully. Inspections ought to be at a minimum of once a year to determine where painting is required. When necessary, the work should be done promptly before excessive deterioration takes place. Care should be given to kind of paint used and the manner in which it is applied. All new work must be thoroughly painted when installed. Painting properly done where and when necessary will prevent deterioration and hence reduce maintenance.

Repairs represent an item of cost which will never be obliterated and therefore should never be neglected. It is possible to reduce this cost to a minimum by proper inspection, by making repairs promptly when needed, by making repairs in a thorough manner; temporary repairs are occasionally neccessary but should never be left up in place of permanent work and by constantly keeping in mind the thought that the cost can be reduced by using proper material and workmanship. The use of copper for skylights and gutters, zinc or specially coated sheet iron in place of galvanized iron siding, brass pipe in place of galvanized for water lines, wood block for flooring, special treatment and method of laying of concrete floors, and many other items will reduce maintenance and should be recommended. Ultimate cost and not initial should be the prime factor in deciding upon materials and workmanship that should go into building and structural maintenance.

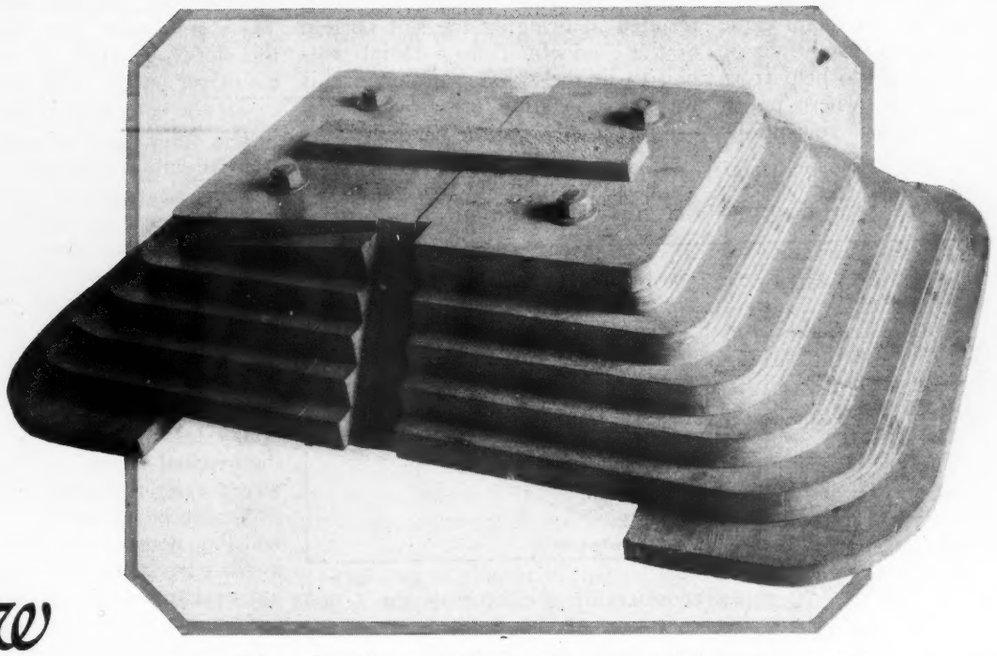


Fig. 1—Gang form for winding a five-coil concentric group.

New Stator Windings for Old

By L. A. COLE

Chief Electrician,
Waterous Limited, Brantford, Ont.

SIX YEARS ago there came into our possession a second-hand 100-kva., three-phase, 2,200-volt, 25-cycle, 750-r.p.m. synchronous motor. This motor was to be used to correct power factor and to drive an air compressor formerly operated by steam. The stator winding was single circuit star and as it was to be used on 550 volts we changed this to a four-circuit star connection.

The machine had been previously used as an alternator and the coil ends had not been stayed to hoops. To withstand the additional vibration when the machine was used as a motor in starting a heavy load such as an air compressor, hoops were installed, but the leads had become weakened previously by the vibration, so that they broke frequently.

Inasmuch as the winding was four-circuit star, one break did not cause a very noticeable effect at starting or even in operation, but two breaks showed up unmistakably. Various failures and finally a ground made a rewind necessary.

Rather than have the factory supply the same type of coil, it was desired to replace this four-circuit winding with a single-circuit star winding. The winding had orginally been a conventional two-layer diamond coil winding. Since we did not have at the time a machine for winding and spreading coils of this size, it was decided to change the type of winding to a concentric winding, and inasmuch as the method used was somewhat original it may prove of interest to other repair men also.

IN THIS practical article, the author describes another way of redesigning stator windings in which can be used only square or rectangular wire in order to eliminate some of the objectionable features Mr. A. C. Roe mentions in his articles.

The original winding had 60 coils, and therefore, coil ends, jumpers, etc., required over 60 soldered joints. The winding as redesigned had only ten soldered connections including the three motor leads and star, which in itself was a saving of time. The new winding used two No. 6 d.c.c. square magnet wires in multiple, which made a rugged coil free from vibration, and one easily laid in the slots. This concentric winding gave better starting results than the previous winding, contrary to what we had expected.

In order to reduce the starting period we had originally resorted to the expedient of starting our steam compressor, then pumping a vacuum with it to get the electric outfit on the line. This was rather a clumsy method and in case the steam compressor was out of commission, we were up against it. We were much

pleased when the new winding was tried out to find that the motor came into step with thirteen revolutions of the flywheel, and with no help from the steam compressor, where previously, about seventeen revolutions were required.

A description of the winding follows and it will be seen that this method can be used only with square or rectangular wire. In Fig. 1, the hardwood form used to wind the coils in groups of five is shown. Six of these groups were required. The three on the outer range were slightly longer on the ends than the three on the inner. The amount of difference was made up by sawing the form in two and inserting a distance block between the halves when winding the coils for the outer ranges. The form was easily made by one of our millwrights and the method of procedure was as follows:

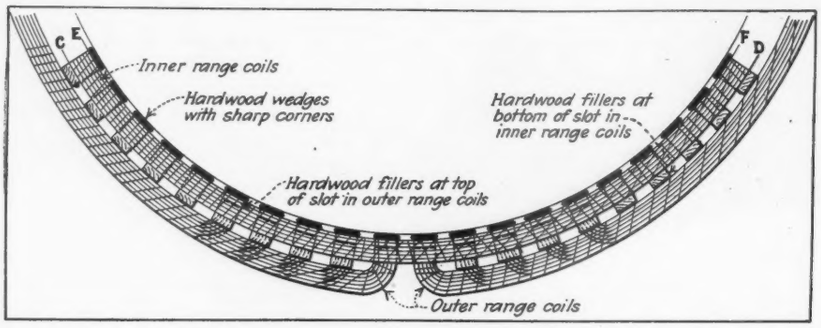


FIG. 2—CORRECT LENGTHS of wire on the coil ends were ascertained by bending a lithe stick around nails driven along arcs *CD* and *EF*. The intervening turns were readily calculated from the lengths of wire in the coil ends.

* * *

Dressed boards were cleated together in order to provide sufficient surface to lay out a full size sector of the stator occupied by one group of coils. This took in twenty slots as shown in Fig. 2. This layout was made exactly to size in respect to slots, bore, etc. By driving a number of nails along the arc *CD* and bending a lithe stick around them it was an easy matter to get the exact length of turn required. In this way by measuring arc *CD,* the length of the outside or longest length of wire in the coil ends was measured, also the shortest length by measuring arc *EF,* and from these two the intervening turns were readily calculated. These various lengths laid out, resulted in a step form as shown in Fig. 1.

A complete group of coils is shown in Fig. 3. When wound, these coils are tied only in the centre and then are placed in a form (Fig. 9) which was used to bend the coils to the proper curvature. This operation resulted in bringing the slot portion of the conductors into a radial position to fit the slots accurately. This form for bending was sawed in a bandsaw easily and the bending operation was quickly accomplished.

The only important point is to see that the curvature of the form is considerably greater than the actual curvature of the stator bore, as the coils will spring back a certain amount. It is well to put in more curvature than actually required, as it is easier to remove the spring than it is to put more in.

These coils were very easy to tape and on account of changing from a flat to a square wire, much more room in the slots was available for insulation. It was, therefore, easy to apply ample taping all around the coil, and also slot insulation. Even at that a large wood filler was required to fill up the space left.

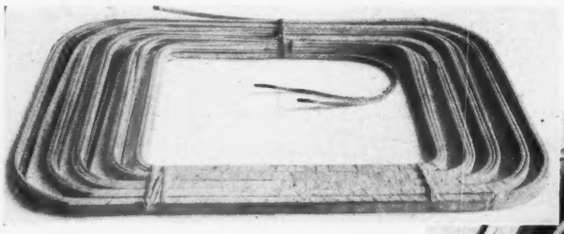


FIG. 3—GROUP OF FIVE coils as wound on the gang form in Fig. 1. These coils, when wound were tied only in the center and were then bent in a circular form similar to that shown in Fig. 10.

* * *

By placing the first or outer range of coils in the bottom of the slots with this filler on top, and the inner range of coils to the top of the slots with the filler in the bottom of the slots, it helped greatly in providing clearance between the crossings of the two ranges.

Wide cotton tape was first used after the coils were formed, then the coils were heated, dipped in varnish and baked. Bias linotape was then applied. Next, another layer of heavy cotton tape, and two more dippings in varnish and bakings. These coils were very easy to put in the slots. A man on one side and his helper on the other were required to lift the coils and do the work.

The outer range of coils had to be bent slightly outwards in order to provide clearance as in Fig. 2 for the crossings of the inner range. This bending was done after the coil was laid in the slots and all wedges driven. This winding has been in steady service for six years, and it has given every satisfaction. The coil making, taping, inserting, and connecting up was done in considerably less time than a winding of the original design could be, and the writer feels that many motors could profitably be wound in this way. It will be noted, that this particular method lends itself to windings having even numbers of pairs of poles and cannot readily be used on windings having odd numbers of pairs of poles on account of the fact that in the latter case there will be one group of coils having one side in an outer range and the other side in an inner.

As stated previously, the machine was originally wound single circuit, star connected, four pole, having 60 open slots, and 60 coils. Each coil had thirteen turns of flat copper, therefore, there were twenty-six conductors per slot. The coils occupied slots 1, and 11. A concentric wind-

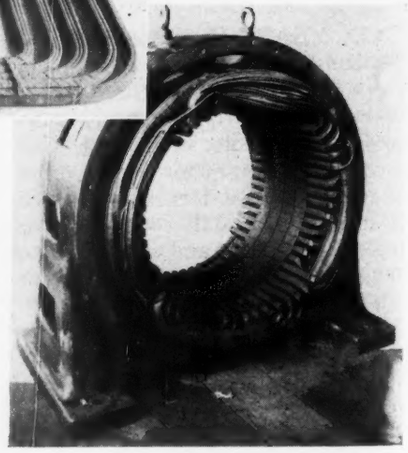


FIG. 4—PUSHED-THROUGH winding on foreign-type stator. The conductors were cut to length, taped and formed on the opposite end. The stirrup was pushed through the slots after being insulated by a mica cell, after which the various ends were formed, brought together and joined by copper sleeves. Several of these joints can be seen in the coils with the taping removed.

* * *

ing such as this must have full pitch, so in this case it would be (60 ÷ 4) + 1 or 16. That is, a coil must occupy slot *1*, and *16*. Therefore, in the original fractional pitch winding five slots were dropped from full pitch. In calculating the fractional pitch use was made of the following formula:

$$\sqrt{\frac{(\text{No. of slots per pole})^2 - 2\,(\text{No. of slots dropped})^2}{(\text{No. of slots per pole})^2}}$$

The slots per pole = 60÷4 = 15, and the slots dropped = 5, therefore, the formula becomes

$$\sqrt{\frac{15^2 - 2 \times 25}{15^2}} = \sqrt{\frac{175}{225}} = 0.882$$

The conductors per slot in the new winding for 2,200 volts = 0.882× 26 = 22.93, and for 550 volts, 5.73 conductors. This being a fraction it was impossible to wind such a coil.

Originally there were five coils in

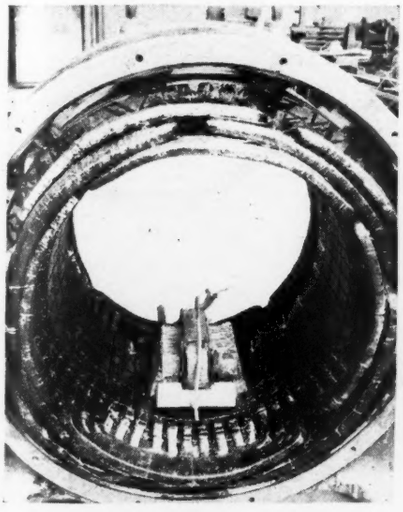


FIG. 5—THE STATOR WINDING which replaced that in Fig. 4. This shows how the first two ranges are bent outwards from the center of the machine to allow the inner range to cross over. Note the "home-made" growler made from a discarded Westinghouse auto-transformer coil. By loosening the through bolt, the laminations may be shifted to conform to a wide variation in stator sizes.

* * *

a group (Fig. 3) completely occupying ten slots. By winding the four inner coils of the group with six turns and the outer coil with five turns the total conductors for ten slots would be (8×6) + (2×5) = 58. Theoretically, ten slots should contain 10×5.73 = 57.3 conductors. As our plant voltage was slightly high, 58 conductors came very close to the original conditions. In a two-layer winding, similar conditions can be met by varying the coil pitch to suit the voltage and turns used.

In the old winding there were 160 lb. of copper, and 180 lb. in the new, however, the old conductors had only 81 per cent of the cross section of the new. The 2,200-volt winding conductor cross section was 0.0105 sq.in. For 550 volts this would become 0.042 sq.in. No. 6 square wire is equivalent to 0.026 sq. in., therefore, two standard No. 6 square wires in multiple were used.

It will, therefore, be seen that if the same conductor cross-section had been used on the new winding it would have had less weight in copper than the old. Had three ranges been adopted on the winding instead of two there would have been considerably less copper still. However, two ranges made it easier to get clearance on the coil ends, as no violent bending of the outer range ends was necessary as in Fig. 2 to provide for the crossing of the inner range. On the outer coils with 5 turns only; a stick equal to the cross-section of the conductors dropped (two No. 6 square wires in multiple) was taped in, in order to preserve the rectangular cross-section of the slot portion of the coil.

Having in mind the success of our

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FIG. 6—GANG FORM for winding coils. Fiber is used to make the steps. The fiber pieces can be stacked together and machined readily in one operation, then they are nailed or screwed to the wood form as shown.

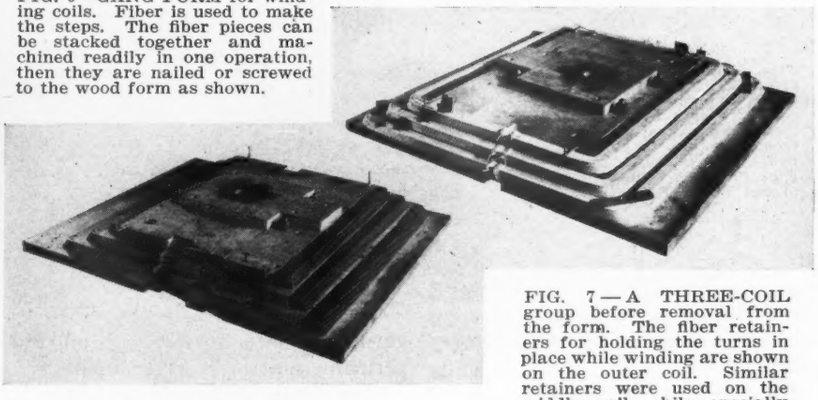

FIG. 7—A THREE-COIL group before removal from the form. The fiber retainers for holding the turns in place while winding are shown on the outer coil. Similar retainers were used on the middle coil while specially bent drapery screws were used on the inner coil.

* * *

efforts on the winding just described, we tried the same method on another second-hand machine which came into our possession more recently. This was a 200-horsepower, three-phase, 25-cycle, 2,200-volt motor of foreign make. Fig. 4 shows a general view of the stator with the original winding which is of the push-through type with the end connections in three ranges.

As in the winding heretofore described there are 60 slots. These coils had originally been made by taping together 20 No. 6 d.c.c. round magnet wires of the required length. Then one end of the coil was formed over wood blocks by bending into a *U* shape first, and secondly by bending this *U* shape down at right angles. The ends of this stirrup were then shoved through the partially closed slots after being properly insulated and the free ends formed over wood blocks to give the same appearance as the other end. The free ends of the conductor were spliced together with copper sleeves. This necessitated the making of 600 joints.

The original winding was star connected for 2,200 volts and we wished to use it on a 4,000-volt grounded star system. We were, therefore, faced with the expense of buying and installing three suitable transformers of a 1 to 1 ratio costing for the three about $1,500, and of standing the loss in them continuously or else of re-winding the motor stator. The latter alternative was chosen. In place of 600 joints there would have been 1,080 in a new winding to work on 4,000 volts, grounded star connected. This looked like a lot of work so it was decided to use a concentric winding similar to the one just described, only in this case the conductors would have to be fed into the slots one by one.

The form used is shown in Fig. 6, and it will be noted that it is a three-gang form instead of a five. This is so because of arranging the coil ends in three ranges instead of two. By noting Fig. 5, it will be seen that in any one range there are two groups of three coils and two groups of two coils. These are all wound on the same gang form.

The new winding had 36 No. 9 d.c.c. square wires per slot. Thus, the coil cross-section was six wires wide by six wires deep. The voltage per turn was over 6, and about 80 between layers which is too much for d.c.c. insulation.

In order to strengthen this feature, every other layer consisting of six wires was taped with 0.007 cot-

ton tape all the way around the coil. This provided additional insulation and at the same time simplified the insertion of the wires into the slots. A layer of six wires was put in at a time and after insertion they held their proper places while the remaining wires were put in. A tamping tool was used in this part of the operation.

The real task was to provide for varnishing and baking. First, a very light coat of varnish was tried but even with a light coat there was an appreciable stiffening of the wires which increased the difficulty of handling.

Therefore, it was decided to lay the coils in without varnishing. After being put in place each coil of the group was taped on the ends with 0.007 cotton tape and then all two or three coils as the case might be were taped together with 0.012 heavy cotton tape.

The machine was wound under a floor-operated electric crane which made handling easy. No varnish tank large enough to dip the motor was available so a large shallow drip pan was placed under it. The varnish was poured over the coil ends after the machine had had a thorough drying out. The slot portion of the coils required different treatment but this eventually worked out nicely. When the coils were inserted, instead of driving a retaining wedge the full length of the slot, only a short one was used on each end and one in the center.

These served to hold the coil down in place and also provided a dam to prevent the overflow of varnish when poured into the slot. The slot insulation had been left long to guide the wires into the slots and it also provided a ready means of guiding the varnish in as well.

Due to the change from round to square copper there was an excess of room for slot insulation. Several successive layers of fish paper and yellow varnish cambric were used. The varnish was poured into the slots by the use of large oil cans with long spouts and the stator turned with the electric crane as necessary. The drip pan used was considerably larger than the machine and it was, therefore, easy to roll the motor and still be over the pan. This feature worked fine and an excellent job of varnishing was made.

Some difficulty was experienced in folding over the insulation on top of the slot portion of the coil after a partial baking. The short retaining wedges previously mentioned were driven out after partial baking; the varnish cambric folded over, and the permanent wedges driven home.

Due to the operating voltage, a good job was necessary in closing over the insulation on top of the coil. This was accomplished with some difficulty. After the permanent wedges were driven the baking was completed.

Varnish cambric was then applied to the coil ends and over it a layer of heavy cotton tape. This was rather a slow process due to too little clearance between coil ranges. It would have been much easier had the winding been in two ranges instead of three. If doing this job again we would use two ranges only. The ease of applying the tape to the coil end would justify the extra weight in copper. After the final application of tape two additional varnish coats were applied and baked.

The motor was set on bricks about 8 in. above the level of the shop floor so that space heaters could be installed under it. A large box lined with asbestos was then lowered upside down over the motor. This method of baking proved to be very effective. A view of the winding after baking is shown in Fig. 5.

Referring to Fig. 6, a spacer will be seen protruding beyond the form. The short or inner range of coils was wound with the spacer removed and the two ends of the form brought together. The center range had a spacer used likewise and the outer range a still wider spacer. This method introduces a slight error in the lengths of the wire on the various coil ends, but it does not cause any trouble in practice and makes possible the use of one form for all the coils.

The method of winding is clearly shown in Fig. 7. The fiber retaining strips may be seen at the corners of the larger coil. In order to provide room for the tape applied to every other layer of wire, as mentioned previously, fish paper tabs were inserted between layers when winding and afterwards removed.

A three-coil group is shown in Fig. 8 which was produced on this form. The two coil groups are wound on the same form using the two shorter forms of the gang. Fig. 10 shows the same group after being bent in a bending form similar to Fig. 9.

Among the disadvantages of this method of winding are, the general appearance of the job does not equal the two-layer job, and secondly the method cannot be used to advantage with an odd number of pairs of poles such as 6, 10, 14, etc., as heretofore pointed out; however, the winding produced without staying devices was free from vibration.

* * *

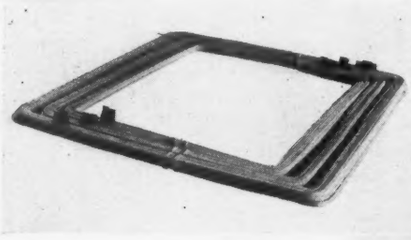

FIG. 8—A THREE-COIL group as it appears when taken from the form. The coils are tied by a stout cord, thus leaving the ends free to assume a position radial to the slots as in Fig. 10 when bent to the proper circular position.

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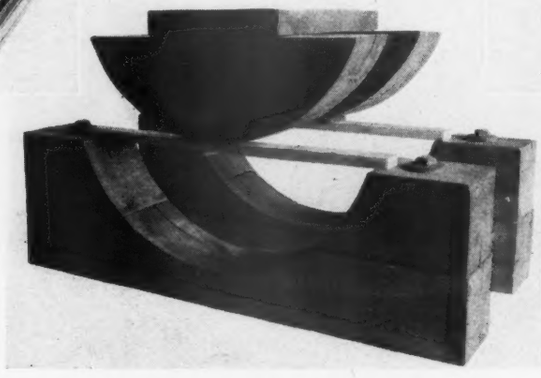


FIG. 9—FORM for bending coils to the proper curvature to fit stator slots.

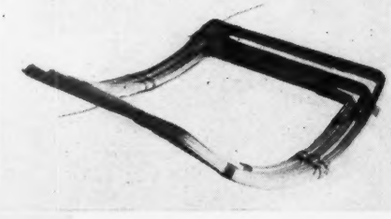


FIG. 10—THE SAME coil shown in Fig. 8 after bending in the form shown in Fig. 9. The form for doing this bending should put in slightly more curvature than is required. Since considerable pressure is required to do this, heavy paper can be used above and below the coil to prevent injury to the insulation.

* * *

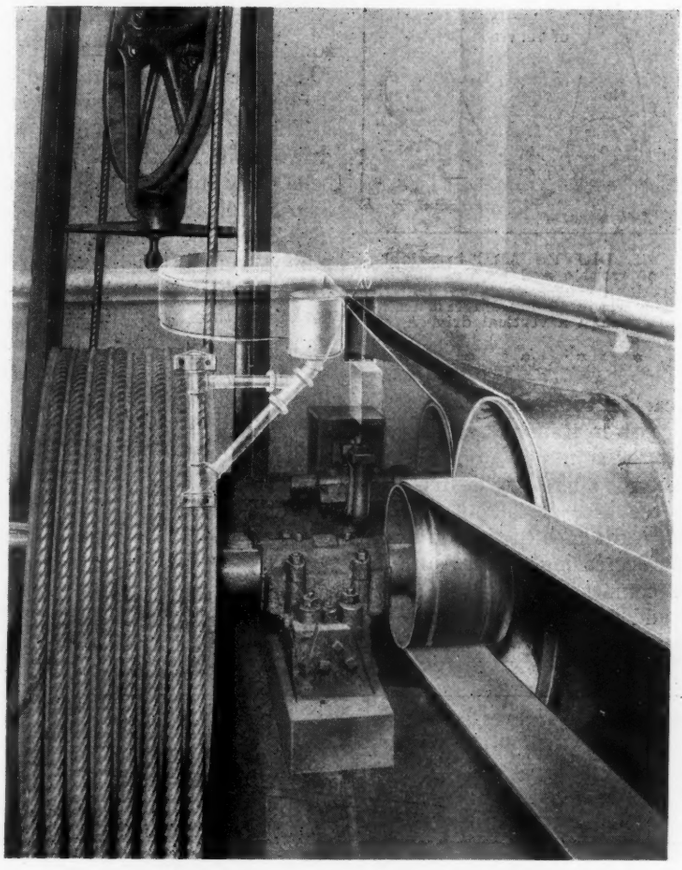
POWER BELT RATINGS

under unusual

Operating Conditions

By R. C. MOORE

Chief Engineer,
Chas. A. Schieren Co.,
New York, N. Y.



Automatic idler on a quarter-turn drive.

FOR A belt to transmit power there must be more tension in one side than in the other. The difference between the tension in the tight strand and slack strand is the effective tension—the measure of the effective work done by the belt. For example, if a belt is suspended over a pulley, which is free to rotate, with a 66-lb. weight hung on one end of the belt and an 11-lb. weight hung on the other end of the belt, it would be moved over the pulley by the difference of the two weights, which is, 66 — 11 = 55 lb. This 55 lb. is the actual weight which is turning the pulley and, as stated above, is called the effective tension, or tension in the belt which is doing effective work.

The rate (in feet per minute) at which the belt travels over the pulley, multiplied by the effective tension, and divided by 33,000 (number of foot-pounds in 1 hp.) gives the horsepower transmitted by the belt.

Instead of using a belt suspended over a pulley with weights hung on each end, let us see what happens in the case of an actual belt drive. The driving pulley, when turning, winds one side of the belt onto the pulley with a given pull and unwinds the other side of the belt onto the driven pulley. The difference between the tension in the tight strand being wound on to the driving pulley and the slack strand being unwound onto the driven pulley is the effective tension which is transmitting a pull to the rim of the driven pulley, thereby transmitting power mechanically from one pulley to another.

The better the surface of the belt can grip the face of the pulley the greater the belt's capacity to transmit power without slipping. Also, since the grip of the belt on the pulley's face bears a direct relation to the pressure required to make the belt grip the pulley, it is evident that a belt with an excellent gripping surface is most desirable, because it produces the lowest possible tension on the bearings and so reduces the bearing load and consequent friction losses.

For example, using the belt suspended over a pulley with weights hung on each end, the tension on one side of the belt was 66 lb. and on the other side 11 lb., or a total bearing tension of 77 lb. In this case the ratio between tight and slack strand is 66 to 11, or 6 to 1, which is a ratio commonly found in drives using a pliable leather belt.

Ordinarily, if a belt has a poor driving surface the belt man merely cuts out a piece and pulls it tighter to increase the pressure of the belt on the pulleys. To secure an effective pull of 55 lb. from a belt with a poor driving surface the tension in the tight and slack strands might need to be increased to 82 and 27 lb. respectively, or a 3 to 1 ratio. This makes the total tension on the bearings 109 lb., which is a 44 per cent greater bearing tension than for a belt having a better driving surface. That is why some types of belts must be run under much higher tension than good leather belts, if they are to

transmit the same load. The surface of these belts does not have as high a coefficient of friction as leather.

The coefficient of friction of a belt is a value which represents the ability of a belt to grip the pulley face. The coefficient of friction of a piece of leather depends, to a large extent, upon the amount of wear to which it has been subjected. A well worn-in belt, in which the leather has been nourished by judicious dressing and has been well cared for, has a higher coefficient of friction than a new one; this indicates that the transmitting qualities of a good leather belt improve with use. Measurements of this coefficient, which were made in leading testing laboratories on various belts, have given the following average values:

New oak leather.....	0.60 to 0.65
Well worn-in oak belting	0.80 to 1.10

The following effective tensions in pounds per inch of width given for belting apply to leather belts operating under normal conditions and allow for a long life with average attention and care.

Heavy singles (16-18 oz.).	55 lb.
Heavy doubles (28-33 oz.).	82½ lb.
Heavy triples	110 lb.

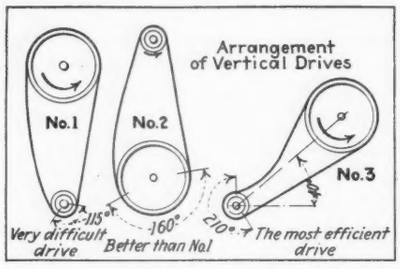
Tables or charts which will give the rating of belts of different thickness and widths at various speeds can be had from all leading manufacturers.

* * * *

A GOOD SURFACE is all important, in power belting; since the tension necessary to transmit power is largely dependent on the belt's ability to grip the pulleys.

These ratings are based on the following conditions: (1) Pulleys no smaller than those listed in the table; (2) slack side of belt at bottom; if at top, deduct 10 per cent from rating; (3) angle of drive not greater than 40 deg. from horizontal; (4) belt speed not over 5,500 f.p.m.; (5) dry and not dusty atmospheric conditions; (6) thickness of belt suited to pulley diameters; (7) arc of contact on small pulley 180 deg.; (8) suitable distance between centers.

Most belt failures and troubles occur among those belts operating in



VERTICAL DRIVES ARE invariably sources of trouble and require special consideration. These sketches help to make clear why a 40 deg. single is desirable, rather than a vertical drive.

* * * *

a vertical position, because of the reduced power transmitting capacity of a belt for continuous operation in this position. The slightest elongation in the belt permits it to drop away from the face of the lower pulley, thus decreasing the pressure and surface contact of the belt on the pulley, and thereby lowering proportionately the belt's power transmitting capacity.

Liberal allowances should be made for vertically operated drives to insure continuous and uninterrupted service. The following table shows corrections and allowances which should be made in determining the proper size of belt for a vertical drive. These corrections apply to the foregoing ratings for belts which, as pointed out, apply to drives operating in a horizontal position.

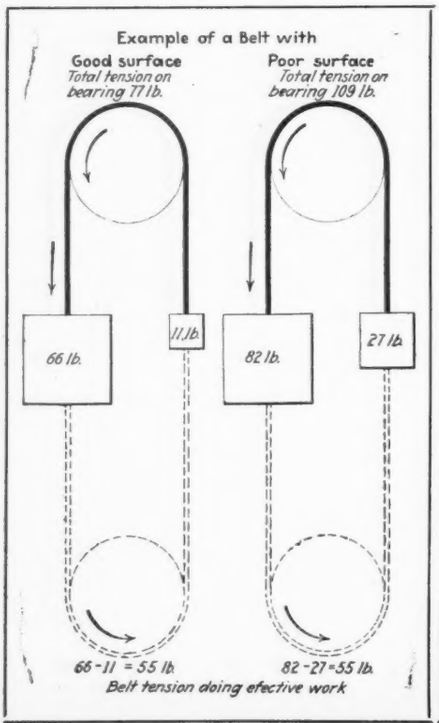
For instance, a belt, which, under normal conditions, will transmit 10 hp. operating in a horizontal position should not be called on to transmit more than 50 per cent of 10 hp., or 5 hp. when operating in a vertical position (90 deg. with respect to horizontal). Note that up to an angle of 40 deg. no correction need be made in the belts' power transmitting capacity.

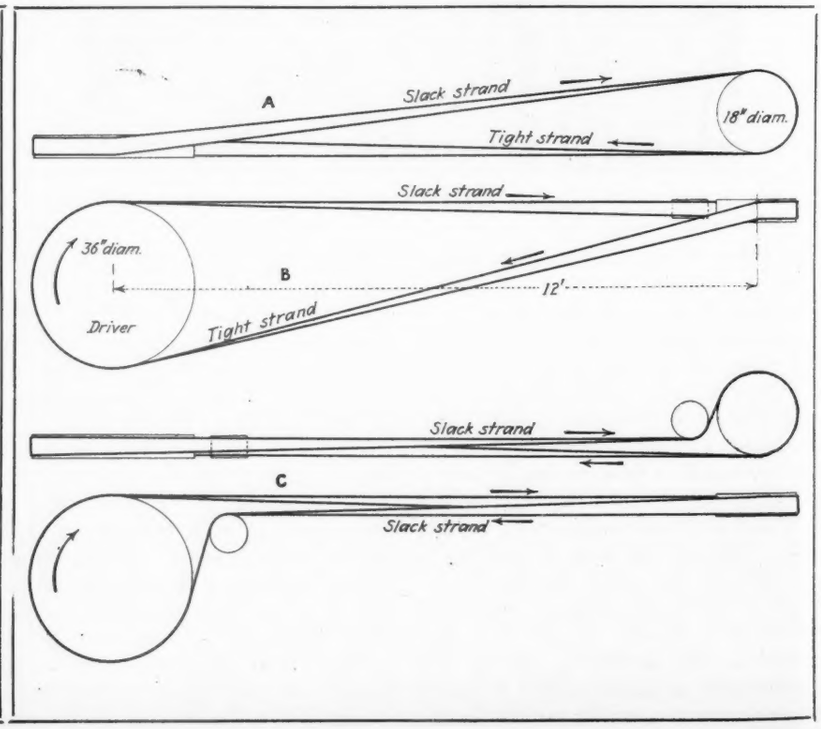
The effect of too high a pulley crown is most noticeable in high speed belts, very small diameter pulleys and flexible idler drives. In the case of high speed belts and small diameter pulleys very often the center portion of the belt is the only portion which makes contact with the pulley, thereby unevenly distributing the pull over the full width of the belt. In some instances the slippage resulting from the reduction of belt contact is great enough to burn a streak through the belt directly over the pulley crown and thus destroy the whole belt.

A high crown on a small pulley

* * * *

QUARTER-TURN BELT DRIVES can sometimes be run with little difficulty as at A, below. B shows an idler to eliminate bucking or puckering, while C shows how two idlers are used for better efficiency.





with a flexible idler located close to it puts a buckling bend in the belt as it leaves the small pulley and runs on to the idler. The weakest point in a belt is back of the point of the lap and directly over the backbone. When the crown of the smaller pulley (the idler should have a flat face) is too high it will crack open a belt in the above location. Turning off the crown is the proper method of rectifying this trouble.

There are no hard and fast rules governing the lay-out of crossed belt drives but for satisfactory operation with a minimum of maintenance the following suggestions are offered:

1. Do not use a shorter center distance between pulleys than given in standard tables.

TABLE I—DEDUCTIONS TO MAKE FOR ANGLE OF DRIVE

Angle Drive makes with horizontal	Deduct from belt ratings
40	0%
50	10%
60	20%
70	30%
80	40%
90	50%

2. Wherever possible avoid crossing belts over 8 in. wide. Use the reverse type drive for wide belts.

3. A crossed belt should not be expected to transmit more than 75 per cent of its rated capacity and in case of pulley ratios of 3 to 1 it should not be more than 50 per cent.

4. Whenever possible the two pulleys should be nearly the same size to make the belt cross midway between the pulleys. In this position the two strands cross without rubbing. When the pulley ratio is 3 to 1, or even 2 to 1, both strands of the belt cross nearer the small pulley and in some cases rub with enough friction to produce rapid wear.

5. If the load is steady and the crossing tends to cause the belt to run off when the pulleys are aligned, a slight offsetting of the pulleys often helps. Throwing the shafts out of parallel should be avoided. This only corrects the troubles for a certain load and with any marked change in the load the belt assumes a new running position. There is always the danger that with any load change the belt will run off the pulleys.

6. Where large pulley ratios must be used, and a reverse drive cannot be used, the location of an idler as indicated will help to make the belt cross at a point where rubbing will be reduced to a minimum.

7. A crossed belt will run better from a small driving pulley to a large driven pulley than it will from a large driving pulley to a small driven pulley.

Open quarter-turn belts should be avoided whenever possible because they can be a constant source of trouble unless very liberal allowances are made when laid out. A quarter-turn belt, particularly a wide one on an open drive, can absorb more power than most people realize.

In the open quarter-turn drive the tight strand is being pulled off the driven pulley at an angle from the center line of the pulley face. This "wiping off," as it is called, absorbs considerable power. It can be largely corrected by the installation of an idler on the slack side of the belt near the large pulley, in cases where one pulley is small.

If both the driving and driven pulleys are large two idlers should be placed in the slack strand, one near each pulley, as shown in the sketch and in the illustration.

Where there is a means of taking care of belt elongation under varying loads the belt on a quarter-turn drive can transmit as much power as on an open drive. But an open quarter-turn drive belt should not be called on to transmit more than one-half of its rated capacity because there is no way to take up belt elongation under full load except by running the belt abnormally tight. This practice is expensive, causes short belt life and high maintenance cost.

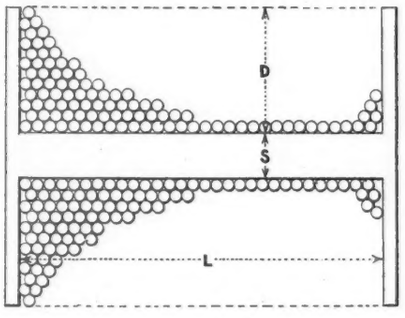
TABLE II—MINIMUM CENTER DISTANCES RECOMMENDED FOR CROSSED BELTS

Driven Pulley Diameter	Driving Pulley Diameter					
	6 In.	9 In.	12 In.	18 In.	24 In.	36 In.
6 in.	.....	.....	15 ft.	.....	.....	.....
9 in.	.....	8 ft.	10 ft.	12 ft.	15 ft.	.....
12 in.	8 ft.	8 ft.	7 ft.	9 ft.	14 ft.	20 ft.
18 in.	10 ft.	9 ft.	8 ft.	8 ft.	10 ft.	15 ft.
24 in.	12 ft.	11 ft.	10 ft.	10 ft.	10 ft.	11 ft.
36 in.	.....	.....	11 ft.	10 ft.	11 ft.	12 ft.

NOTE:—Center distances recommended here are minimums. When driving from a 12-in. driving pulley to a 24-in. driven pulley minimum, a center distance of 10 ft. is recommended. If the case is reversed and the drive is from a 24-in. driving pulley to a 12-in. driven pulley the minimum center distance required is 14 ft. This must be kept in mind at all times when laying out crossed belt drives

How to Determine Length of Rope on a Drum

AS A ROPE, cable or wire winds upon a shaft or reel, it ordinarily assumes a position similar to that shown in the accompanying



THIS DIAGRAM indicates the dimensions needed when determining the length of rope on a reel.

illustration. So, if it is desired to wind the maximum length of rope onto a reel, the turns of rope in one layer should fit into the "valleys" between the turns in the preceding layer and, of course, the rope should be kept fairly taut while it is being wound.

In order to determine the number of feet of rope on a reel, it is necessary to obtain four dimensions. Three of these are indicated in the accompanying diagram, and the fourth is the diameter of the rope, wire, or cable being used.

The following formula, which employs these dimensions, is a simple one and can be worked out very easily:

$(D + S) \times D \times L \times 0.3 \div$ (rope diameter) = length of wire or cable in feet.

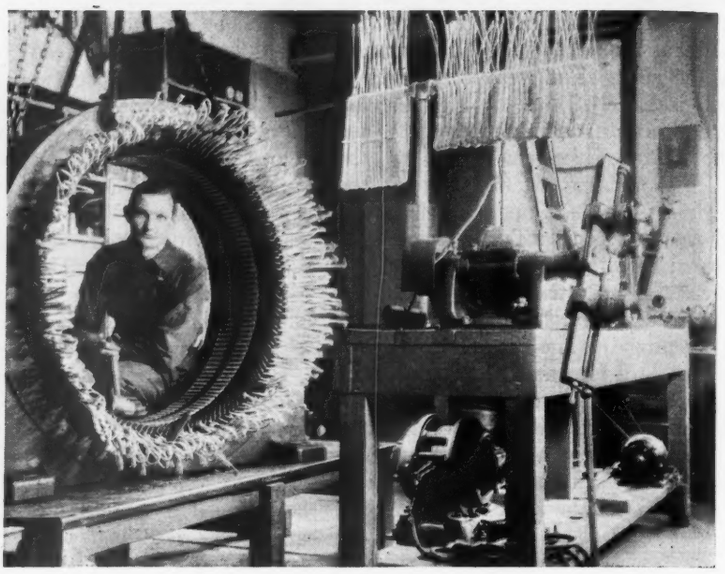
All the dimensions used in this formula are in inches. D represents the over-all depth of the layers, S the diameter of the core, L the inside length of the reel, and 0.3 is a constant that is used regardless of the size of the reel.

W. F. SCHAPHORST.

Mechanical Engineer,
Newark, N. J.

Good equipment well arranged, helps to get the most out of the

Electrical Repair Shop



Replacing stator coils on 150-hp., 440-volt motor—one of the largest jobs ever handled here

—*says* C. H. MUNCH

Chief Electrician
The Rubberoid Company
Jobel, Ill.

UNDOUBTEDLY the prevention of interruptions in the operation of equipment is the most important of the responsibilities in industrial maintenance and plant operation. The ability to make all necessary repairs both quickly and economically is, perhaps, the next most important factor in determining the success or failure of such activities.

If reliable equipment is used on work for which it is suitable and is inspected and serviced regularly and properly, interruptions will be less frequent. This is a subject which deserves extensive treatment, and will be touched on only briefly here; the present article, however, will deal with the facilities at our plant for making the electrical repairs.

This plant is engaged in the manufacture of felt base, asphalt-coated roofing in the form of rolls and shingles, including making the felt and the preparation of the coatings. We have a motor installation of about 3,500 rated horsepower. Altogether, there are about 200 motors, of which 18 use direct current and 182 alternating current. A number of variable speed drives are employed in the manufacture or processing of the felt and roofing products. The motor ratings vary from 200 hp. down to fractional horsepower units. In addition, two synchronous motors of 300 and 490 kva. rating are connected to d.c. generators. About half of the electrical power used is made by two steam-driven alternators and the remainder is purchased.

The biggest problem in maintaining the electrical equipment results from the dust that comes from the slate which is used as a surfacing for the roofing and shingles. Bearing failures are, therefore, the cause of the larger proportion of all of our motor troubles and are responsible for about 90 per cent of the rewindings.

The plant operates continuously on a six-day schedule and, therefore, motor interruptions on any of the key machines may interfere seriously with production. To anticipate, and so prevent, as many of the motor failures as possible, two men, each Sunday, blow out each motor, flush the bearings, add new oil, and check up worn bearings by inserting feelers in the air gap. If the bearings on an important motor are badly worn, these men change the bearings. Wherever possible such extensive work is reported and changed during the week. Daily routine inspections also keep the motor failures low.

Because of the continuity of plant operation and the desire to keep the investment in spare motors and armatures as low as possible we have felt it imperative to make our own motor repairs and rewinds in addition to general maintenance and the installation of new electrical equipment and distribution systems. All repairs, except those at the machine, are made in the electrical repair shop, which is shown in the accompanying illustrations and floor plan.

Up to about three years ago, previous to my connection with the company, all rewinding of motors was sent to an outside company. The introduction of the Segur coil winding, spreading and taping equipment, together with fewer repairs, due to the regular inspections, made a reduction of about $6,000 the first year in labor and material alone in the department. This shop has demonstrated the value of good, well arranged equipment in reducing the cost of repairs.

The shop is about 18x25 ft. with windows on the north and west sides. Clothes lockers, shelves with steel drawers for miscellaneous small parts, bolts, nuts and so on, which are kept in the repair shop, and tool cabinets line the south wall. The 4x4x5-ft. oven is in the corner with the switch and automatic temperature control equipment mounted alongside.

The dipping tank is placed along the east wall. This tank is oil sealed and has a capacity of 3 bbl. of varnish, although only about 2 bbl. are kept in it. The tank is mounted on casters so that it can be wheeled under the I-beam monorail for dipping motors and heavy armatures. The wire reel is mounted on the east wall in line with the coil winder on the bench.

The steel top of the work bench along the north wall cannot be damaged or splintered by the heavy work which is performed on it. Small motors which can be lifted easily and other rough work are repaired and

tested out on this bench. The ground indicating lights on the a.c. and d.c. main distribution circuits and the connections to 440- and 220-volt, three-phase, and 110-volt, single-phase, 60-cycle, alternating current, and 220-volt, direct current are mounted on the test board just above this bench. The chief electrician's desk and the individual tool chests for the electricians are placed along the west wall. The bench is so constructed that nothing can be set on the floor under it. A bottom shelf is placed about 6 in. from the floor and this makes it easier to keep the shop clean.

All coil making equipment, which was supplied by the Electric Service Supplies Company, Chicago, Ill., is placed on a well-built wooden work bench, 24 in. wide, 8 ft. long and 34 in. high, which is placed about the center of the room. This table contains a Segur 40-in. loop winder which is driven by a 2-hp. motor through a standard lathe head. The spreader also is a standard Segur unit. The Segur taping machine is the standard 36-yd. unit and is driven by a ½-hp. motor. Both the winding and the taping machines are foot-treadle controlled. A portable 18-in. shears for cutting insulation also rests on the bench.

Heavy motors are lifted and turned with the 1-ton Yale & Towne chain block on an I-beam monorail extending lengthwise of the room. Such work is rested on a low, steel-top repair bench about 30 in. wide, 6 ft. long and 17 in. high. The large motor which is being worked on, is shown in one of the accompanying illustrations, resting on this bench.

All machine work, such as turning armatures or shafts or rebabbitting of bearings is sent to the machine shop, which adjoins the electrical repair shop.

Because of the limited space, this arrangement is the best we have been able to lay out. Every piece of equipment is accessible and close to the next operation. Coil winding, motor repairs and miscellaneous shop work is used for fill-in by three men who service trouble and do other emergency and installation work. Repairs are made to control equipment but it is possible, usually, to do this without bringing it to the shop.

The large stator shown in an accompanying illustration is one of the largest jobs ever handled in our shop. This is a 150-hp., 600-r.p.m., 440-volt, 60-cycle, three-phase, 12-pole, General Electric motor and requires 144 coils, each 0.101x0.250 in., with five turns, and a coil span of 1:10, connected three-circuit star. About 250 lb. of d.c.c. copper magnet wire were required.

A previous repair job on a motor of the same type and rating cost $100.15 for labor, copper wire and insulation. The cost of varnish and baking are charged into the general expense of the department. Mica insulation is used in the slots of this motor and we believe that the less labor required and longer life gained more than make up for the extra cost of insulating material.

All coils are dried out at 220 deg. F. and then dipped, while warm, in No. 460 General Electric black baking varnish. The coils are then baked, taped, dried, dipped and again baked; thus, each coil has two coats of varnish insulation baked on. Because of the variations of motor types, sizes and speeds, it is not practicable to make up coils before needed. Meggar tests are made on all completed jobs before okeying.

Carbon tetrachloride is used for all cleaning purposes instead of gasoline. Because of the reduced fire hazard, it can be used safely anywhere in the plant; also, it cleans faster and better. Acetylene tanks with hose and burner are used in the shop and plant instead of gasoline blowtorches, because of decreased fire hazard and greater efficiency.

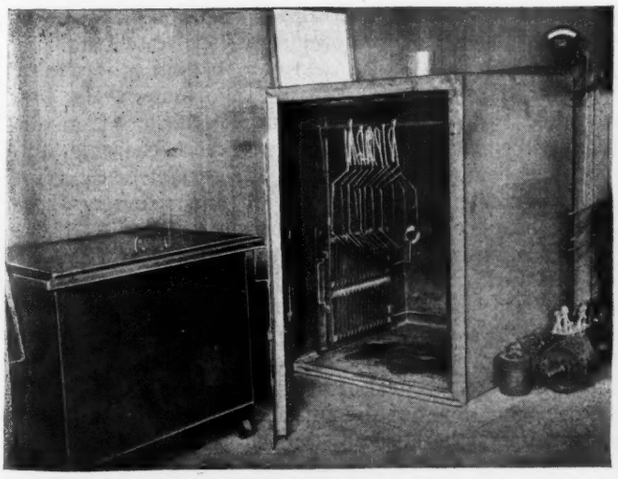
Practically all supplies are carried in the general storeroom which is accessible at any time. When a rewinding job comes in, the spool of wire and the insulation are weighed up, and charged out to our department. When the job is finished the remaining material is returned to the storeroom for credit; the difference is charged against the particular job. This plan might not be so practicable in some shops but it works very satisfactorily here.

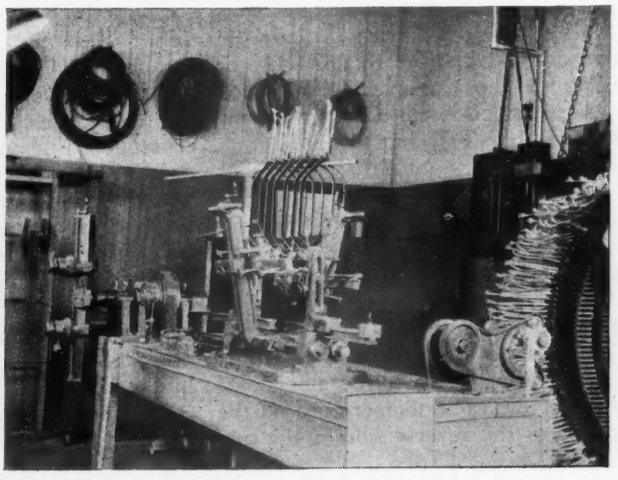
A brief explanation of our routine in handling orders may be interesting. A card record of every motor, armature and control is kept by equipment number in the chief electrician's office. These cards contain all data on the equipment and, in addition, have space on the back for entering all repairs. A study of this card indicates any excessive trouble and we can then look for the cause.

An example of the value of this record is in connection with an unduly large number of new bearings which one motor required. A study of the drive indicated the use of a

* * * *

COIL-BAKING OVEN AND OIL-SEALED DIP-TANK. Oven temperature is regulated automatically; the actual temperature is indicated on the dial on top of the oven. The varnish tank is on casters and is pushed under the monorail hoist for handling heavy armature or stators.





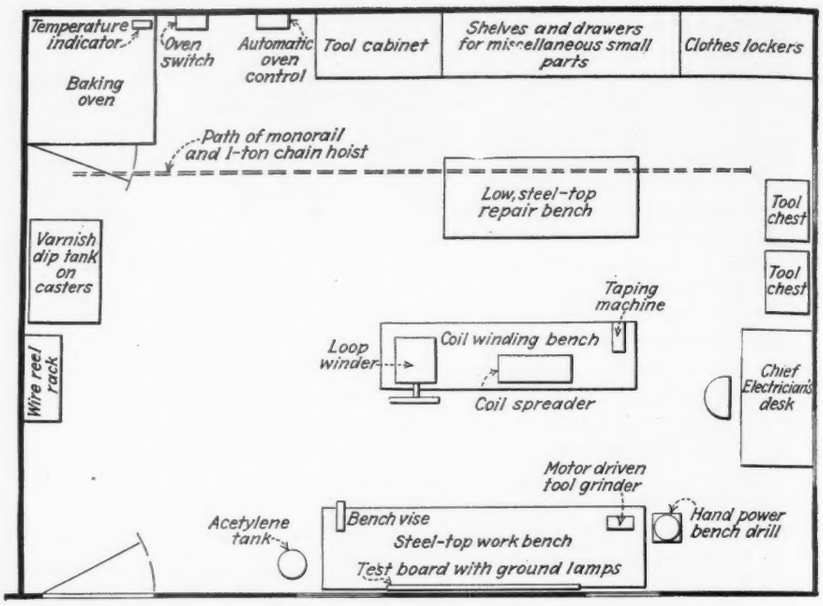
ALL COIL-MAKING EQUIPMENT IS MOUNTED TOGETHER. The loop winder is mounted on this bench in line with the wire-reel rack on the opposite wall. The coil spreader is mounted about the center of the bench and the taping machine at this end. Both the loop winder and the taping machine are motor driven and foot-treadle controlled.

silent chain instead of a gear train. This change, seemingly, has solved the problem.

Whenever a motor comes in for repair all work and material is charged against the motor number. This expense is then entered by the cost department against the department or machine using the motor, whether it is returned to that department or put in with the spare motors. In other words, a department is debited with all expenses incidental to putting the motor in condition before a credit can be entered for it. Also, all maintenance and new installation work is charged against the production department served.

All of the effort toward lowering operating costs need not be directed toward the repair shop alone. Much can be done toward keeping work out of the shop or eliminating it altogether. The regular inspection routine is one example. Another is a minor change made in the remote control equipments. It required spending regularly four hours per week to clean up the push-button contacts and also to make frequent renewals because of the pitting. These were changed from a metal-to-metal contact to a metal-to-carbon contact by the addition of a carbon washer. These cost about 9 cents each and are fastened to the disks by two small screws. The washers are put on one side of the metal disk for open and on the other side for closed circuits. The carbon washers are not affected by fumes or frequent use, are easily and quickly attached and have eliminated entirely the weekly servicing. Many similar time-saving ideas eliminate a multitude of miscellaneous small interruptions to service. This has given the department more time to concentrate on emergency work.

The chief electrician also keeps charts and records of the cost of the major items of supplies and various types of work. Any undue trend upward is noticed and the cause located and remedied.



ARRANGEMENT OF EQUIPMENT IN REPAIR SHOP
This 18x25-ft. room serves as the repair shop and the headquarters of the electrical department. All machine work is sent to the machine shop, which adjoins this room at the left. The only machine tools here are a hand-power bench drill and a small tool grinder. This prevents duplication of equipment and also aids in specialization in repair work.

* * * *

Vitreous Enameling in the Electric Furnace

ONE essential requirement in the operation of vitreous enameling furnaces is uniformity of temperature throughout, even though the flow of heat varies in different parts of the heating chamber. Uniformity of temperature depends upon the type of furnace and its design.

The development of the metallic-resistor type of electric furnace for temperatures of 1,500 to 1,850 deg. F. usher in the use of electricity for fusing vitreous enamel. In this type of furnace, according to Publication No. 267-28, National Electric Light Association, the control of heat flow is so complete that uniform temperature may be applied in baking a complex shape, even though the heat flow or heat quantity varies in different parts of the charge, as in apron type bathtubs. Here, no difficulty is met in delivering the required amount of heat at the same temperature on the apron or the reverse side of the tub.

Several types of furnaces have been used in the past for baking or "burning" enamel ware. These differ mainly in the method of applying the heat. In fuel-fired furnaces the effect of the products of combustion necessitated the use of a muffle which inclosed the work and kept out smoke, fumes and other products of combustion.

With the development of the electric furnace there came a method of heating in which the muffle and its consequent heat waste could be abandoned. The resistance-type heating unit gives off heat without combustion, reducing the escape of heat from the furnace, through ventilation, to an absolute minimum. In fact, the opening of the door to charge the furnace constitutes the only loss of heat, aside from the heat absorbed by the walls and that radiated.

In the fuel-fired furnace the time of burning is dependent upon the cooler portions, and a compromise must be made between the hot and the cold portions of the furnace, which may result in some parts of the charge being slightly overfired and other parts being slightly underfired. If the furnace has large variations, the ware must be turned.

To insure a uniform product, the furnace must be capable of maintaining a constant operating cycle of temperature. In operation, the furnace temperature will vary from the maximum just before charging, followed by a sudden drop when the furnace is charged and rising again as the charge becomes heated. If this cycle can be made to occur regularly and identically, then the furnace has controllable temperature suited to the work of vitreous enameling.

Where electricity is used, a great deal of attention is paid in the design of the furnace to the conservation of heat.

A Simplified Method of Controlling

Maintenance Stores

By J. S. MURRAY
Chief Electrician,
and

C. L. SHULTZ
Storekeeper
Follansbee Brothers Company,
Toronto, Ohio

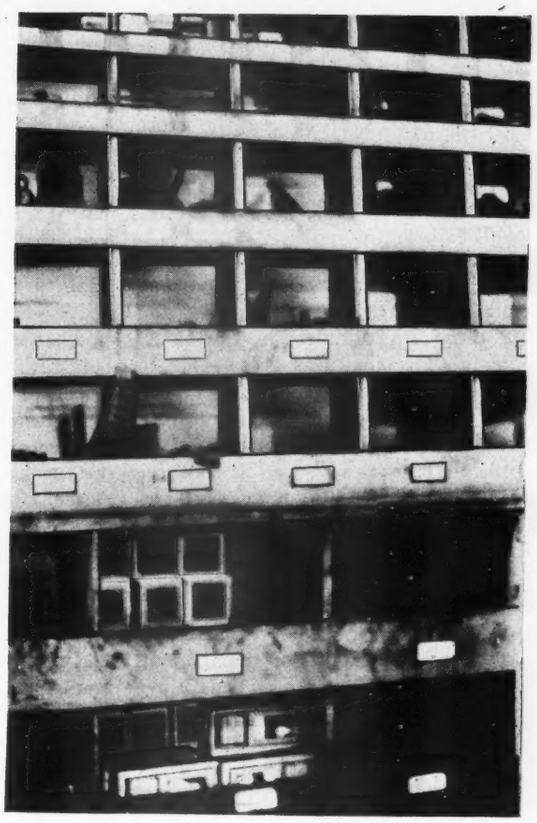


FIG. 1—MECHANICAL and electrical stores are handled in the same storeroom.

* * * *

MUCH has been said regarding the importance of maintaining a low inventory on the materials used in production. The inventory on supplies and repair parts should receive as much attention and can show corresponding savings.

A steel plant, particularly where it is isolated, must have sufficient quantities of all repair parts to make any repairs and the necessary supplies and materials for emergency and minor new construction. Material for extensive construction programs should be ordered for the job.

In handling maintenance stores and supplies much depends upon the arrangement of the stores and the method of keeping records of receipts and disbursements. For example, the system used should be simple, yet complete enough to show at all times the quantity of material or supplies on hand, when more should be ordered, receipts and issuances, unit cost, and the account or order number to which the items issued should be charged. Also, the requisition and work order should tie in with the stores and cost systems.

Before going further into the description of our stores and stores methods it may be well to list briefly the extent of the Toronto plant and the activities of the electrical department. This plant consists of open hearth furnaces, hydraulic presses for forging ingots into bars, a bar mill, sheet mills, annealing furnaces, power house, coal mine and other auxiliary and necessary adjuncts to plant operation. A feature of this plant, which is unusual, is that the ingots are reduced by forging under a hydraulic press, instead of by a blooming mill, and then rolled in a bar mill. The product of the mill is finished steel sheets which are used in automobile bodies, steel furniture and other metal products.

The electrical department has supervision over about 1,000 motors, rating from 2,000 hp. down to fractional horsepower units. In addition, 27 cranes, the charging machines, forging manipulators, coal mine machinery, pyrometer installations, and the entire electrical distribution system.

Plant repairs are handled either by the electrical or mechanical departments. The electrical department makes all electrical and mechanical repairs on all electrical equipment, or equipment which, in the nature of its operation, is primarily electrical, such as cranes, charging machines, forging manipulators and other similar equipment. This mechanical work includes repairs to bearings, gears, pinions, shafts and so on. In addition, the department does all new electrical work and makes all changes or alterations.

The mechanical department handles the repairs to other equipment and plant. This article, however, will cover largely the stores activities of the electrical department.

All work is done against a department order number. Special jobs, such as new work or extensive alterations, are given individual job numbers; the regular routine activities, such as repairs and maintenance, the card of accounts is provided designating a symbol for individual equipment in which is shown the cost symbol for recording. Work, which, it is estimated, will cost not over $100, can be done on the requisition of a department head. Larger jobs must be approved by the manager.

The use of the McCaskey System has been found most effective for the issuing of store supplies and the compiling of both material and labor costs. Relative to labor costs, the McCaskey System is used only to cover non-producing labor such as in shops, general yard, floating labor, and so on.

One of these forms which is used

as the material requisition, is shown in Fig. 2. This is made out in triplicate by an authorized party in the electrical department, the original and triplicate copies are given the store tender at the time the material is issued and the duplicate copy is retained in the book for departmental records.

These McCaskey requisitions are bound in book form, the original and triplicate copies can be removed and the duplicate retained in the book. The filled requisitions are passed to the stores office at the end of each day, where they are priced and assembled in the McCaskey boxes. The triplicate copy is removed at the time they are filed in the boxes and returned to the electrical department for their job records.

The method used in disbursing electrical supplies from the main storeroom is the same as that employed by the electrical department. Stores identification, which constitutes the lettering of aisles and the numbering of the bins, and the bin markers give a description of the part or parts contained in the bin. This description is made to correspond with the stores office record as shown in Fig. 3, which is a visible card record.

By the use of the visible record system considerable time is saved over the former ledger, or the indexed card systems, in addition to being far more accurate.

The visible card form, as shown in Fig. 3, is used only to accumulate the receiving records of the commodity and to assemble the average unit cost of each shipment. The unit cost is very desirable information due to the numerous grades of same commodities purchased through the different sources. Fig. 4, or the cover sheet for Fig. 3, is used for the disbursement of the commodities only, and carries a stock balance as well as the average unit cost of the stock on hand.

In pricing the McCaskey requisitions, they are first arranged alphabetically, according to the supplies issued. By using this method only one entry is made each day against the record, which adds materially to the speed and simplicity of the system. After pricing, the requisitions are carefully checked for carding against the apparatus or department to which the material is to be charged and then are arranged in their numerical sequence according to the carding number. An aggregate total in dollars and cents is taken to determine the amount of credit due the electrical stores account.

The original requisitions are then assembled in the McCaskey boxes or files, Fig. 6, which are arranged to show the amounts charged to the different cardings to date, and are balanced out after each day's business by means of a ledger sheet crediting electrical supplies and charging mill apparatus.

All other mill or mechanical supplies, and so on, are handled in the same manner, only that they are divided into classes, and are so credited when they are charged to the mills.

Classifying the material is a very simple matter and is indispensable inasmuch as the stores turnover controls the inventories. Classifying makes it an easy matter to locate the high spots and a quick adjustment can be effected. It has been found that by using this system an actual physical inventory is required only once a year and little or no adjustment is necessary.

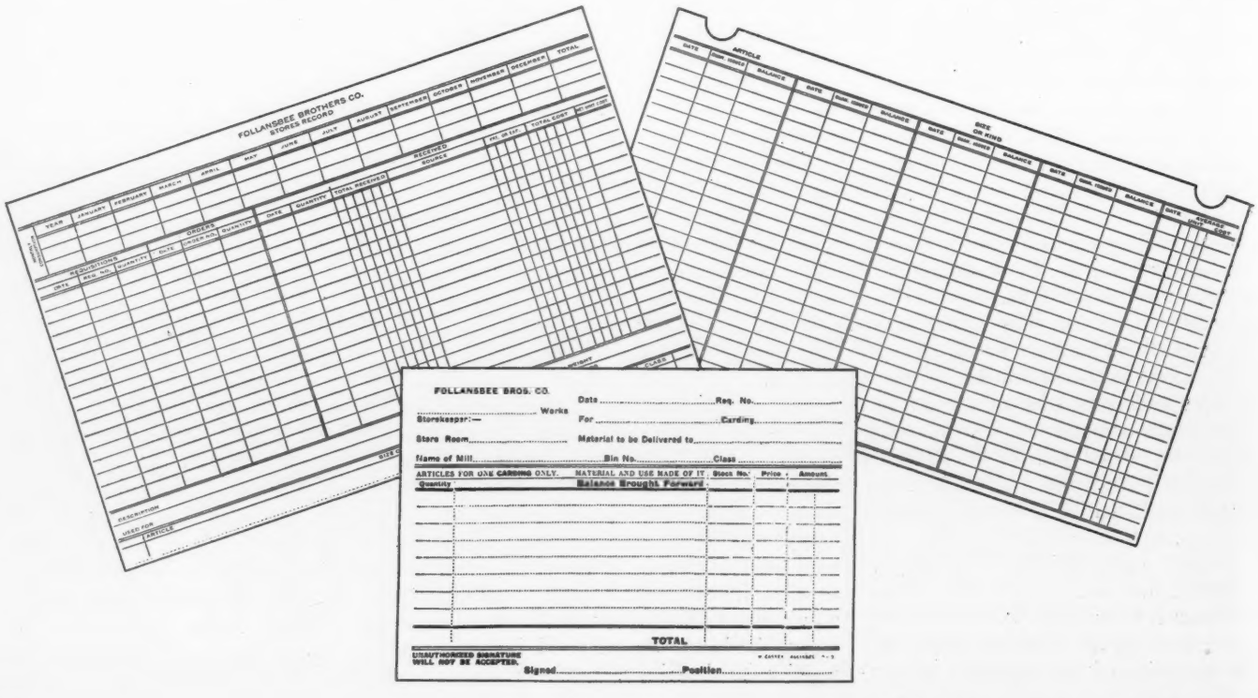
It might be well to mention that the electrical stores at present embody more than 3,000 items while the mechanical and other stores have about 5,000 items. This represents a decrease of more than 400 items in the two years the system has been in operation. A number of items were found to be obsolete, due to standardization of equipment.

In ordering material for stock a daily low stock sheet is made out by the store tender at which time the actual bin stock is checked against the book stock and proper adjustments made in order that the book records will be as nearly correct as possible.

The question of the best method for handling large spares which are

* * * *

FIG. 2 (*Bottom*)—MATERIAL requisitions are filled out in triplicate. The original and triplicate are sent to the store tender and the duplicate retained by the department issuing it. Fig. 3 (*Left*)—Visible card records are used to handle stores records because of their convenience. Fig. 3 is used to accumulate the receiving records and to assemble the average unit cost. Fig. 4 (*Right*), which is the cover sheet of Fig. 3, is used for disbursement of commodities and carries the stock balance.



carried on the mills such as coupling boxes, spindles, mill pinions, drive shafting, and so on, has always been in doubt. We have found that, by designating a certain place in the mill to stock these different spares and giving them a spare number and by using the same method of recording as applies to stores, we have greatly improved our system.

The visible card system employed for this work is put up in book form, Fig. 5. These books are carried into the mills once each month and checked for quantities on hand. In this way the material is charged in the month in which it is used and does not necessitate any additional help as the mechanical and electrical department clerks carry on the checking of these spares.

The arrangement of the stores has much to do with the ease of issuing orders. For example, we try to place all component parts of any piece of equipment together. That is, all parts of a control unit, say, are grouped as near together as possible. If a man is repairing a control unit he may want two or three different pieces and the more closely grouped, the easier they are to issue. Heavy parts, however, are stored on the lower bins or shelves, naturally.

The men are encouraged to study repair-parts lists so that they can ask for supplies by the correct name or number. This, also, saves a considerable amount of time and prevents misuse or disapplication of material.

One of the most important items in connection with stores is to keep the inventory as low as possible, consistent with safety. The stores records, Figs. 3 and 4, carry a balance of stores on hand and also maximum and minimum amounts to have on hand. When the balance gets down to the minimum the clerk issues a requisition for a reorder, which is sent to the purchasing department through the chief electrician's office. This gives us an opportunity to stop orders on parts which are becoming obsolete or increase orders where our experience tells us that a particular part will become more in demand.

Probably the greatest aid in decreasing the amount and value of stores is by standardization of equipment. Some manufacturers use standard parts over a wider range of their equipment than do some others and we have taken advantage of this fact in the selection of equipment.

In other cases it has been necessary for us to do our own standardization. A few examples of what we have done may suggest methods which may be used by others. For example, it seemed that almost every crane used different sizes of bridge or trolley track wheels. Heat-treated, tool-steel bridge and trolley wheels are used exclusively and so we had to order and store a variety of sizes, many of which differed only by fractions of an inch on some one or two dimensions.

* * * *

FORESIGHT is defined as the third great factor of personal planning that causes one to look ahead and to prepare in advance for everything that needs to be done. Similarly

Next Month

INDUSTRIAL ENGINEERING will stress in advance of winter the things that need to be done now for the Heating, Ventilating, Dust, Air and Fume removal, and Air Conditioning Systems in the plant.

* * * *

We tabulated the different sizes and found that most of the differences were in the hub and bore dimensions. As a result, we selected a few sizes according to wheel diameters and flange sizes with the maximum hub dimensions and minimum bore. Now any wheel in stock can be machined to fit any crane using a wheel of the particular diameter. These are now ordered in small lots of a size instead of one or two of every size.

Formerly crane cable was ordered in reels and cut off as desired. This almost always left a length of cable which was just too short to use. A study of the cables needed for the different cranes indicated that a few standard lengths could be ordered cut to length and so have no waste.

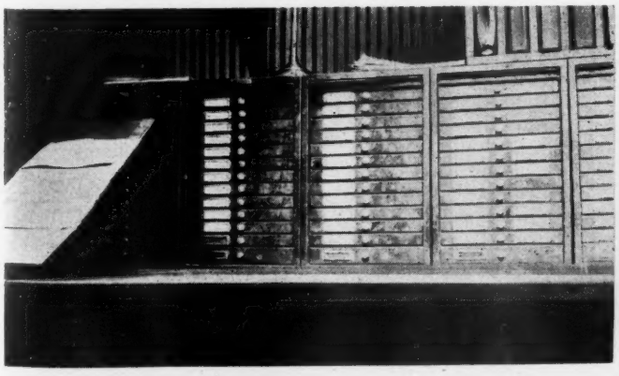
A study of carbon brushes led to the elimination of about 200 sizes, grades and shunt lengths. A table shows what size and grade on hand are to be used in each particular place. A standard, enclosed type switchboard, incorporating standard units, is used on all 27 cranes and wherever else possible. These are only a few of the standardizations which were made.

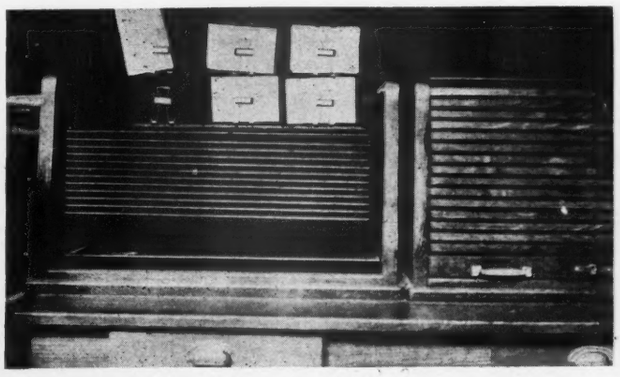
How much we have been able to decrease our inventory by standardization is difficult to estimate; it would amount to many thousand dollars at least. With the lower stock which we need to carry it is possible to turnover our inventory of repair parts and supplies about $2\frac{1}{2}$ times a year and we are still finding opportunities to increase this turnover without risking serious trouble by decreasing to a dangerous point the minimum quantities carried. That is, we believe it is safer and more economical to have a fewer number of items rather than smaller quantities of each item.

* * * *

FIG. 5—THE VISIBLE card record cases where the records, Figs. 3 and 4, are kept. The cards are hinged at the top and overlap like shingles on a roof.

FIG. 6—SECTION of the McCaskey register used for collecting the material requisitions, Fig. 2, so that a single entry is made on Fig. 4 for the daily disbursements.





INDUSTRIAL ENGINEERING
with which is consolidated
INDUSTRY ILLUSTRATED
Electrical, Mechanical and Plant Service in Industry
Published by the McGraw-Shaw Company

New York, August, 1928

Jot It Down

MANY a good idea has been lost because of the lack of one or all of three things. A pencil, a notebook or the habit of making notes. Little argument is needed to prove that ideas are the most powerful things that we have to deal with, yet how many occasions have arisen when the BIG idea was a mere impulse, potential in value; and eventually forgotten because no record was made of the mental transaction? Very little would we know today of science, arts and literature if we had to depend solely upon the spoken word. Civilization began when ideas were put on record. Ideas, freely exchanged through the medium of trade papers and technical journals not only accelerated the industrial movement in this country, but helped to make it the leader. To keep it so, to make your job bigger and to make your plant more efficient; not by word of mouth; or unspoken thought, but through recorded ideas, jot it down!

Serving the Whole Field of Business

EXTENSION of the Mc-Graw-Hill publishing activities to every branch of American business is the most significant effect of the merger of the A. W. Shaw Company, of Chicago, and the McGraw-Hill Publishing Company, announced on page 370 of the July issue of *Industrial Engineering*.

Heretofore, the magazine publishing activities of the McGraw-Hill organization have been confined to specialized service to major engineering industries and the trade channels for distributing their products. The book division of the organization, it is true, has long since broadened its scope; it publishes books not only on engineering, management and industrial subjects, but on general business and scientific agriculture.

Through the merger the McGraw-Hill institution now acquires a medium by which it can speak to the whole range of American business. "The Magazine of Business" has a circulation of more than 150,000 copies and deals with the problems fundamental to all business—such as those of finance, production, distribution and sales, management, transportation and export trade. It treats, as well, those major movements in legislation which bear upon business, such as taxation, tariff and government regulation.

The importance of this new extension of the McGraw-Hill activities is apparent to all who have followed the standards which, under the leadership of James H. McGraw, have dominated its publications. To give, through effective organization, the best of which they are capable, is his constant admonition to the publishers and editors working under his direction. It presages a virile development of an already effective service to the whole business structure of America.

Further, it is significant that in referring to "The Magazine of Business," Mr. McGraw in his announcement of the merger, closed with these words, "It will fight for the interests of business but it will place in an equally important position, the responsibility of business to the public. It will, in a word, stand for true business statesmanship."

Past performance in McGraw-Hill papers, is a warrant that this pledge will be fulfilled.

Economy May Cost More Than It Is Worth

USING an expensive recording meter as an indicating instrument for more than nine years, in order to save the cost of charts and ink, would seem to be the ultimate in economy of operation—or foolishness. And yet, that is precisely what was done in one New England plant. No doubt this misdirected effort to cut operating expenses did result in keeping a few dollars in the bank, but one can only guess how many hundreds or thousands of dollars were wasted through inefficient operation that might easily have been detected.

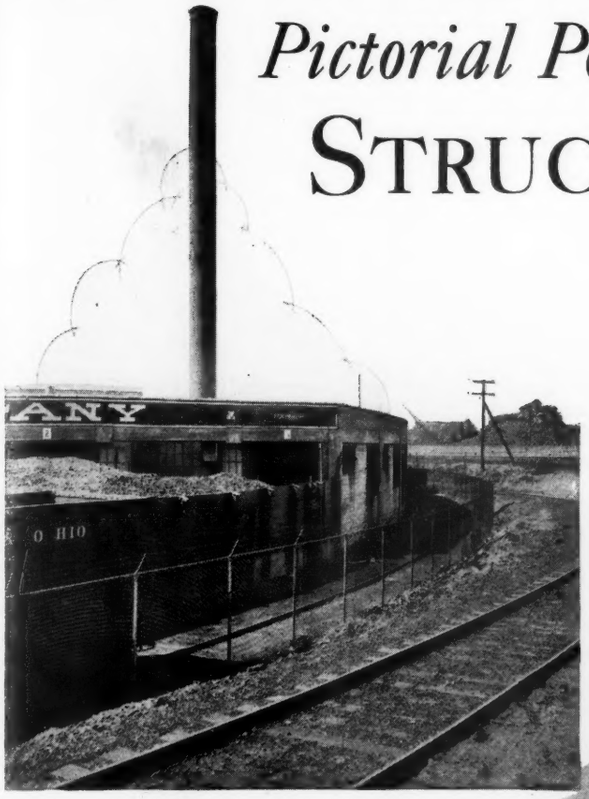
We may smile and shake our heads over this incident, but other cases of pinching pennies while dollars slip away are not nearly so rare as they should be. In a great many plants an observant visitor will see plenty of instances where power in one form or anther is being wasted for lack of proper means of checking up consumption and losses; where equipment is being sadly neglected in order to save the wages of a few men, while repair costs and losses due to production delays mount higher and higher; or where various plant operations are being conducted with utter disregard of efficiency, through lack of proper equipment.

Sometimes these conditions are the result of plain ignorance, but more often they are due to a desire on the part of someone to practice economy by keeping expenditures down.

Caution in making expenditures is highly laudible, when exercised with discretion. Obviously, however, failure to hire men who are really needed, or purchase equipment of any sort that will eliminate guesswork or improve the efficiency of plant operation is simply evidence that the wrong definition has been given to the word Economy.

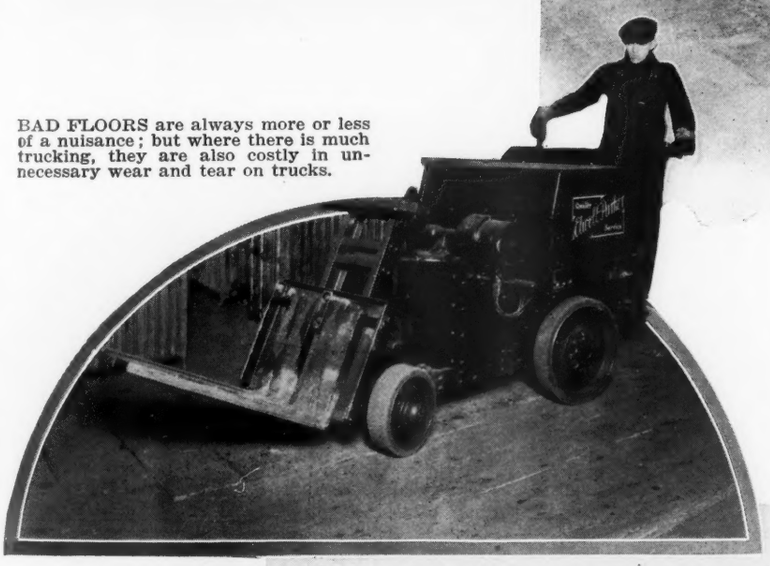
In its real sense Economy means spending money wisely—not hoarding it.

Pictorial Pointers on STRUCTURAL REPAIR *and* MAINTENANCE



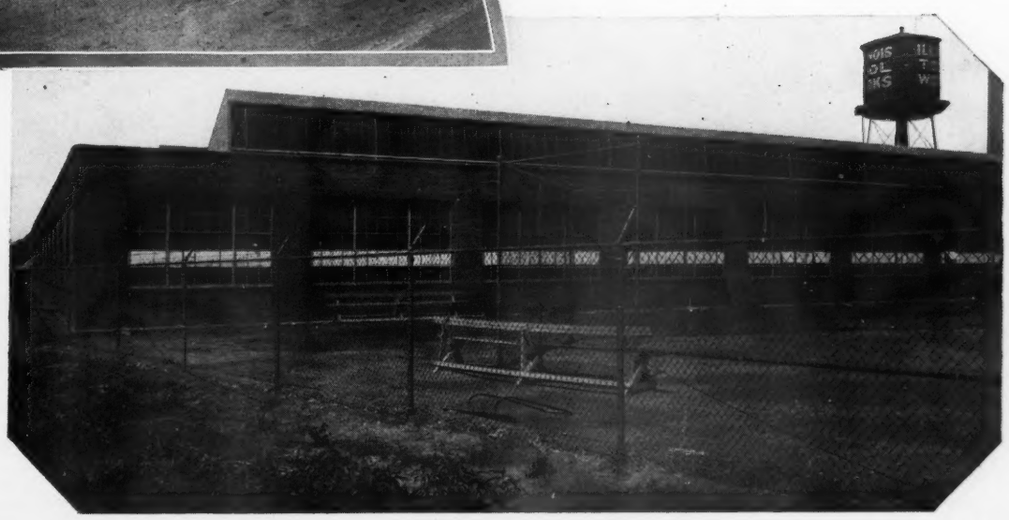
NOT ONLY regular painting, but periodic attention to the guy wires, is the requirement for long life of a steel stack.

BAD FLOORS are always more or less of a nuisance; but where there is much trucking, they are also costly in unnecessary wear and tear on trucks.



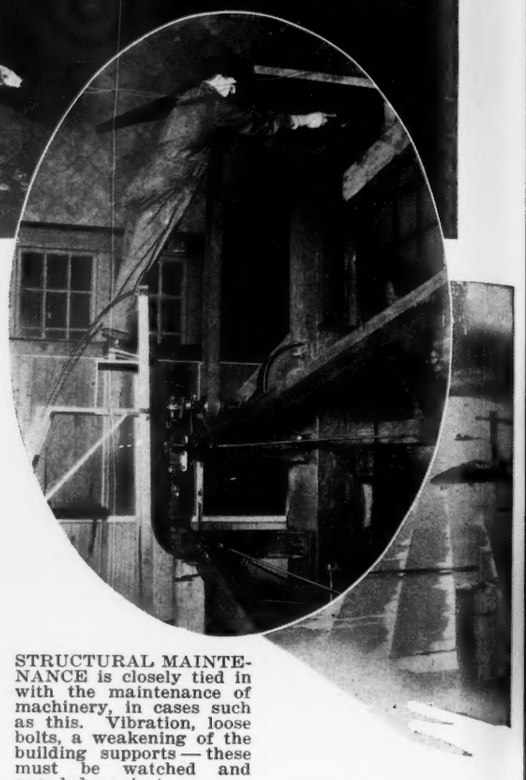
A GOOD BUILDING deserves a good roof. Instead of constantly patching the old one, it often proves a paying investment to replace it entirely with one requiring a minimum of upkeep.

THE WELL-KEPT industrial building not only lasts longer and serves better, but it wins the goodwill of the community and affects the morale of the entire personnel.



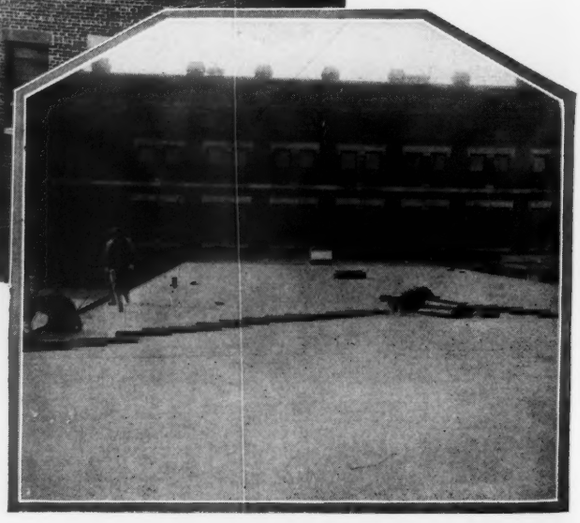
A PLACE that needs frequent inspection, is the flashing around skylights and chimneys. The better grades of modern built-up roof provide special protection at these points.

WINDOW CLEANING, glazing, painting; these, and the mechanical details of sash operating mechanism, are a few of the details which no progressive plant engineer will neglect.

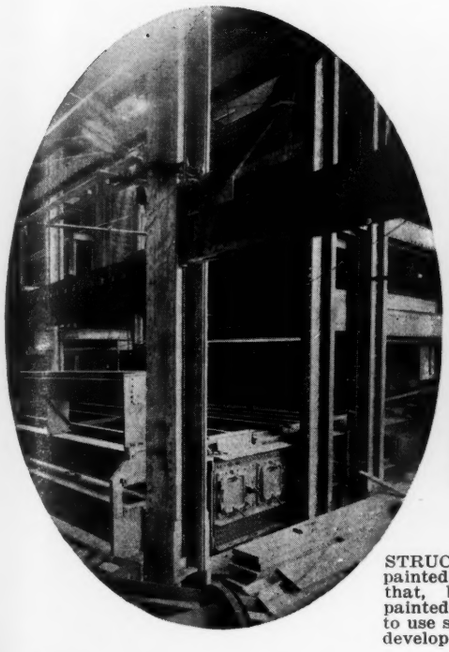


STRUCTURAL MAINTENANCE is closely tied in with the maintenance of machinery, in cases such as this. Vibration, loose bolts, a weakening of the building supports — these must be watched and guarded against.

A TAR AND GRAVEL ROOF should be inspected regularly for thin spots, and gutters and downspouts must be kept clear. As with all roofs, the flashings should be inspected frequently and carefully.



NOTE THE FACT that this second layer of roofing is being laid crosswise to the first, and with wide overlap; assuring a good, lasting job.

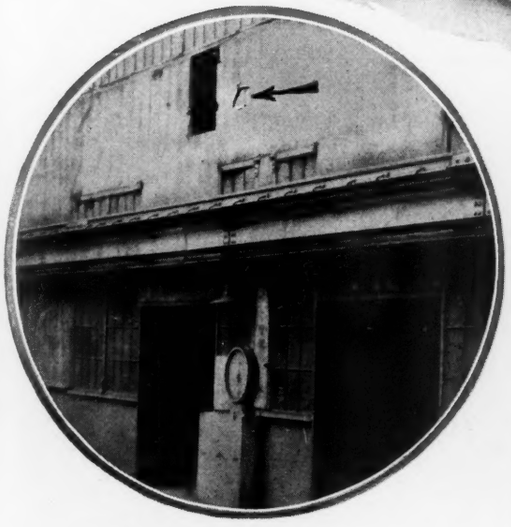


AN EXCELLENT EXAMPLE of a saw tooth roof so built as to require a minimum of repair and maintenance. These modern roofs, while higher in first cost, often cost less in the long run.

STRUCTURAL STEEL must be painted, and kept painted. Not only that, but it must be properly painted, to withstand rust. It pays to use some one of the special paints developed for this service.

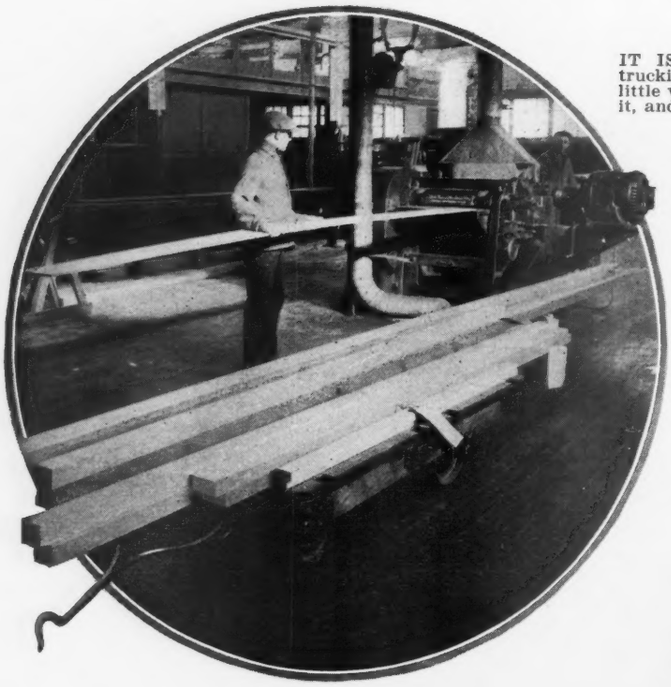
THE MODERN plant of any size is too valuable and too vulnerable to remain unprotected. Vandals and mischievous boys, alone, are good arguments for fencing the property.

SUCCESSIVE LAYERS of asbestos felt and asphalt are being applied here to provide a durable roof with excellent heat insulating qualities.



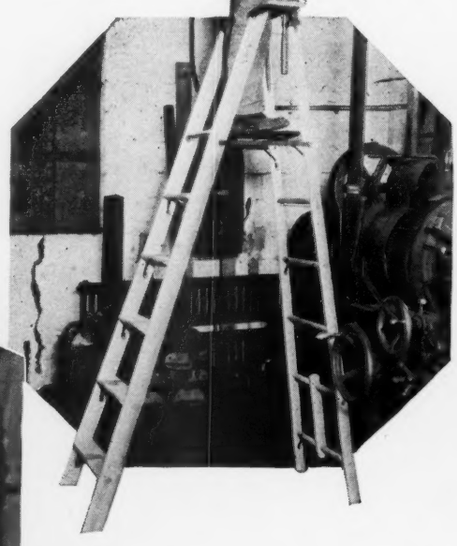
THE TIME TO REPAIR such a spot in a concrete wall is when it first shows. Better yet, prevent it by sealing the minute cracks by means of a cement paint.

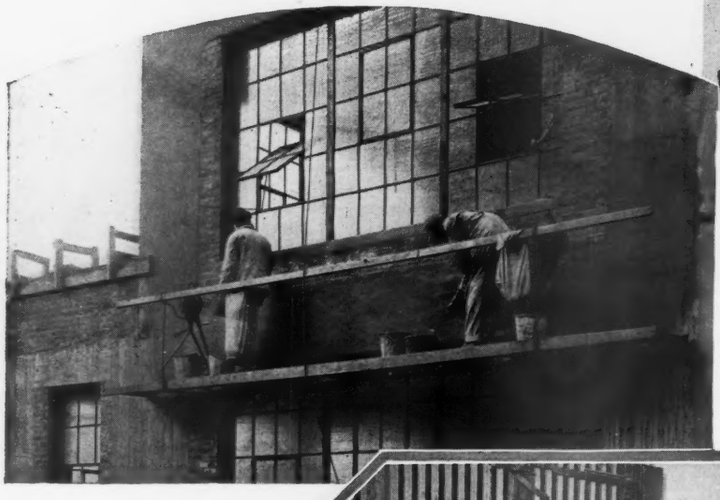
DURABILITY is being built into this concrete floor at the very beginning, by metallic hardening compound. Where wear is severe, it pays to rebuild a floor, rather than try to maintain one which won't stand the gaff.



IT IS GOOD ECONOMY to provide regular trucking aisles, where the main floor receives little wear; resurfacing these aisles as they need it, and avoiding the need for patching.

NOTE HOW THE CRACK in the wall, under the window, has been filled in. Even small cracks at such points should be repaired, else the weather tends to enlarge them.



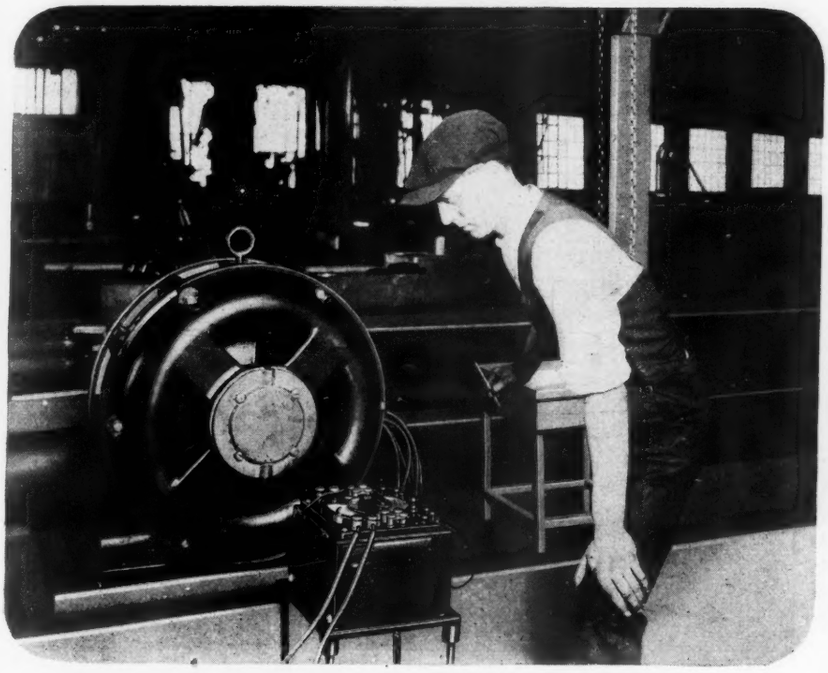


WINDOW FRAMES should be inspected each fall, especially as to cracks at the sill. Unless these are promptly repaired, the damage spreads.

DOOR SILLS, especially where there is much trucking, should be kept in repair to save unnecessary wear and tear on trucks. The doors themselves should be regularly inspected and lubricated.

Testing INDUSTRIAL PLANT EQUIPMENT

HERE AN INDICATING WATTMETER IS BEING USED to measure accurately the input to a motor.



By E. S. LINCOLN
Consulting Engineer,
New York, N. Y.

Operating the complicated equipment of a modern industrial plant in the absence of proper testing instruments is about on a par with navigating a ship without a compass. It can be done, after a fashion, but the chances of trouble or disaster are increased a thousandfold. Whenever guesswork is substituted for facts, intelligent direction and efficient operation become almost impossible. In this article the author points out some of the uses of testing equipment and shows by examples the results that have been accomplished in the way of saving power and improving plant operation.

* * *

INDUSTRIAL plant engineers know, or should know, that it is impossible to obtain reliable and efficient operation of electrical systems without providing a systematic and periodic inspection and testing program. This work is absolutely essential for the successful and economical operation of any plant. Proper tests and inspections require the ascertaining of facts—guesswork cannot be tolerated. Just because a motor is apparently operating satisfactorily each day does not mean that it is doing so economically, or that it will continue to do so. The work it is doing, and its condition, should be carefully checked from time to time.

In plants where no systematic method of testing and inspecting is in use, it will be necessary to inaugurate some such system. After all information relative to the operation and condition of the equipment has been properly tabulated it will not be a difficult matter to keep the system up to date. If the load on motors, for example, remains the same, it is not necessary to make tests continually. If, however, any loads are changed additional tests will be required to determine the new conditions under which the motors are operating. In laying out an inspection and testing system only one that can be kept up to date and that will be understood by others in the department should be considered.

In properly conducted testing work no "leak" is too small to be ignored. For example, with a rate of 2 cents per kilowatt-hour a saving of 1 kw. means a saving of $48 per year of 300 days of 8 hours each. Saving 10 kw. under the same conditions amounts to $480 and so on. Furthermore, saving 200 watts or 0.2 kw.-hr. on a 10-cent rate equals the same saving as 1 kw.-hr. on a 2-cent rate.

Savings should also be sought in connection with the distribution system, and in the use of every piece of apparatus, such as motors, generators, transformers, lamps, etc., for it must be constantly borne in mind that electrical equipment will generally operate at its highest efficiency only when fully loaded, as specified on the nameplates. This is particu-

larly true of motors, which consume more electrical energy than all other electrical equipment used in the average industrial plant. Hence, it is apparent that when motors are underloaded or overloaded, or when the proper percentage of the power consumed is not applied to useful production, there is certain to be loss or waste of power.

To illustrate the necessity of using the proper motor in the right place, in one plant a 20-hp. induction motor was installed on a blower to carry a 10-hp. load, which meant that the 20-hp. motor was operating at 85 per cent efficiency. With a rate of 3 cents per kilowatt-hour the saving in power alone would be $21.60 per year, assuming an 8-hour day. Moreover, a smaller motor would improve the power factor of the system and the investment would be less.

Space does not permit the listing of all equipment on which savings may be made. These savings may be divided into two classes, the first of which involves the common-sense operation of equipment; this means that apparatus that is not producing should be stopped, unnecessary lamps turned off, motors shut down when not in use, and the elimination of useless and unnecessary equipment.

The second class of savings is somewhat more difficult to make, and requires the checking up of all apparatus to see that it is operating properly and efficiently. It also includes the removal of unnecessary loads, such as shafting, belting, etc. In this case the determination of the facts requires engineering training and the use of accurate electrical measuring instruments.

These two classes of savings can be expected in practically any industrial plant, and although the saving on each item may be small, the total will be found to be a large percentage of the total power consumption.

The following incident is taken from actual experience and is illustrative of conditions as they exist in many industrial plants today.

A certain plant had in use fourteen motors, ranging in size from 2 hp. to 100 hp., which at first gave fairly good service with only an occasional shutdown due to motor trouble.

Several accidents had, however, occurred in the plant, due to failure of portions of the lighting system, and to add to the inconvenience they had occurred at critical moments. Again, with only a small increase in production, the power cost kept increasing rapidly and more and more outside assistance was necessary for the electrical department, due to numerous operating troubles with starters, motors and other equipment. Upon receipt of the largest power bill in the history of the company, the management ordered an investigation.

The first question that the consulting engineer asked was, "Have you any electrical measuring instruments in your plant?"

The answer was ,"No. What good would they do us?"

Further conversation brought out the fact that the electrician in charge had requested a few meters to test the system to determine the loads on all the motors, but his request had been refused. He was unable to convince the management that these meters were necessary. However, upon the recommendation of the consulting engineer a set of electrical measuring instruments was purchased and the results of a test lasting only a few days were a revelation to the management.

A VOLTMETER AND AMMETER will quickly show whether a motor is carrying its rated load.

* * *

The following conditions were found to exist:

Number of motors	14
Rating	2 to 100 hp.
Total rating	507 hp.
Total load on motors	504 hp.
Friction load	185 hp.
Power factor of system	78 per cent
Total losses	250 hp.
Power rate per kilowatt-hour	1 cent

From the above data it was evident that the actual load delivered by the motors was approximately equal to their total rated load. The average was good, but a careful analysis showed that some motors were considerably underloaded, whereas others were overloaded and excessively hot.

A voltage survey showed that many motors were receiving as little as 80 per cent of their normal rated voltage, and that the distribution losses throughout the plant were excessive.

The motors were originally intended for 220-volt service, but were reconnected at a very small expense and operated at 440 volts, which cut the current required in half, thereby reducing the distribution losses. After rearranging the loads on some of the motors and adjusting belts, shafting, etc., a second test was made with the following results:

Total rating of motors	507 hp.
Total load on motors	510 hp.
Friction load	160 hp.
Power factor of system	85 per cent
Total losses	190 hp.

It will be seen that an additional 6 hp. was being consumed, but this was accounted for by increased production of the plant requiring 66 hp. more, which was very economically obtained in the following manner:

Purchased from power company.	6 hp.
Reduced friction and belt losses saved	25 hp.
Decreasing electrical losses in the system, increasing efficiency of motors, increasing the power factor saved	35 hp.
Total	66 hp.

The cost of the power thus saved or in this instance, the increased production with approximately the same cost, in less than one year's time paid for all the measuring instruments and changes in the plant.

Now measuring instruments are in frequent use in this plant, as periodic tests are made every six months. Moreover, it is very seldom necessary for the electrical department of this concern to require outside assistance.

Another actual case demonstrates the value of test instruments in securing reliable operation of electrical apparatus.

Due to the breaking of a large pipe in a pulp mill, a 500-hp. synchronous motor was soaked with liquid pulp for fifteen or twenty minutes. The pipe was replaced in a very short time and the motor washed off with a hose, leaving it apparently in perfect condition. However the management of this plant took nothing for granted and being always prepared for any emergency, immediately made a thorough test of the motor. The test showed that careful handling was necessary for a time, but the motor was running perfectly, a few hours later.

Without the use of instruments to determine the condition of the motor it would have been very unwise to start it, as it would have been impossible to know what damage might result. Plant electricians often have to make a quick decision and without proper instruments they are often compelled to take unnecessary chances with expensive equipment.

Proper lighting is a matter of extreme importance in industry, so as to assure satisfactory working conditions with maximum production per worker, and to eliminate accidents caused by fatigue produced by insufficient illumination.

The incandescent lamp is very susceptible to voltage changes. If the voltage differs from that which is specified on the lamp, one of two things will result: if the voltage is too low the amount of light will decrease rapidly, and if it is too high the life of the lamp will be greatly decreased. The voltage at all points in the system should be checked and

WITH AN INSULATION RESISTANCE METER the condition of electrical equipment can quickly be determined.

* * *

if it is not correct, the voltmeter will show whether the cause is within the factory or is due to inefficiency of supply, so that in either event the cause may be located and remedied.

There are, of course, many other places in which electrical instruments can be used to advantage. Indeed, their use is becoming indispensable as the application of electrical energy in the various industries increases steadily. The majority of manufacturing plants that do not use testing instruments probably could through their use readily reduce power and lighting costs by at least 10 per cent, and in many cases by as much as 30 per cent.

In the most efficient plants where no substantial economies can be obtained, it is worth the price of a few instruments to know that this condition exists and to be assured that it will be maintained.

Industrial plants that have been completed within the past few years have been able to take advantage of the more efficient modern electrical machinery and methods of operation.

The engineers in charge of the original installation undoubtedly used electrical indicating instruments for checking the equipment, to assure compliance with specifications calculated to produce maximum efficiency. Nevertheless, as time goes on, changes are made in the existing equipment and new machines are added to meet the demands of increased production. If the changes and new installations are not carefully checked by the proper tests the plant will soon become as inefficient as many of the older plants constructed years ago.

Testing work can be divided into two parts, the first covering the inspections and tests of a somewhat routine nature necessary for the reliable operation of any plant. The second part involves the reduction of losses and increasing the efficiency.

Briefly, the work to be accomplished may be summarized as follows:

First Part

Securing reliable operation.

Decreasing depreciation.

Reduction of repairs.

Removing inefficient plant equipment.

Determining the necessity of additional plant equipment.

Determining whether purchased equipment meets specifications.

Second Part

Determining when and where losses occur.

Increasing the efficiency of apparatus, individually and collectively.

The first part of the above work consists principally of inspections and proper planning, good engineering, etc. When the first part of the work is properly handled such items as depreciation, repairs, etc., will be automatically taken care of. In other words, a plant that is properly designed and constructed will fulfill all the requirements of good operation.

In order to accomplish the results suggested in the second part, engineering skill, proper measuring instruments, and good, common-sense judgment are required.

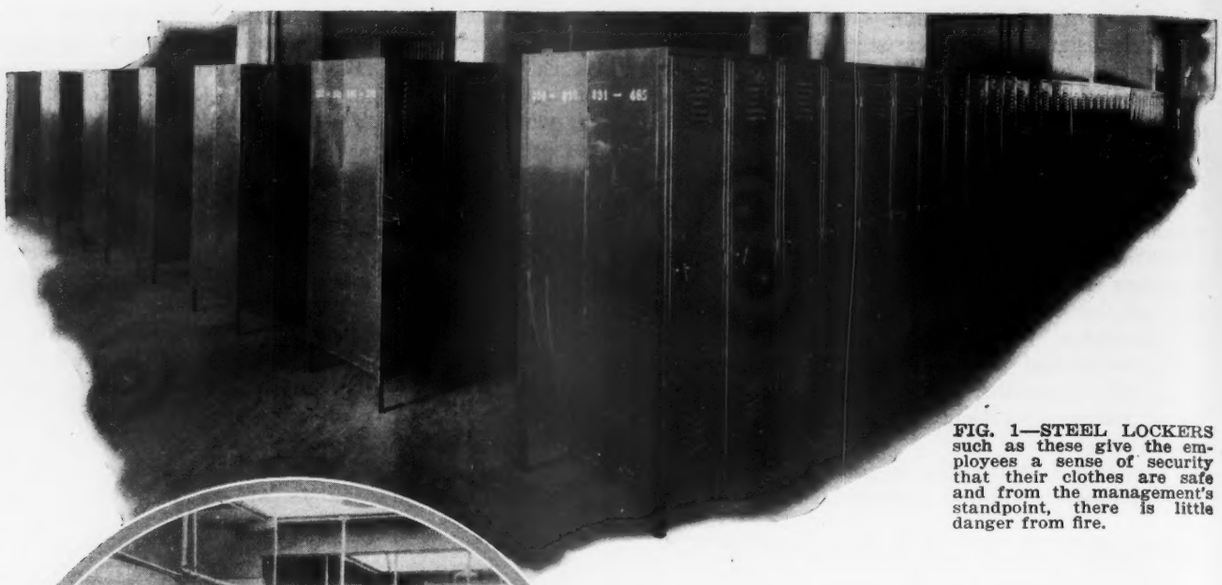


FIG. 1—STEEL LOCKERS such as these give the employees a sense of security that their clothes are safe and from the management's standpoint, there is little danger from fire.

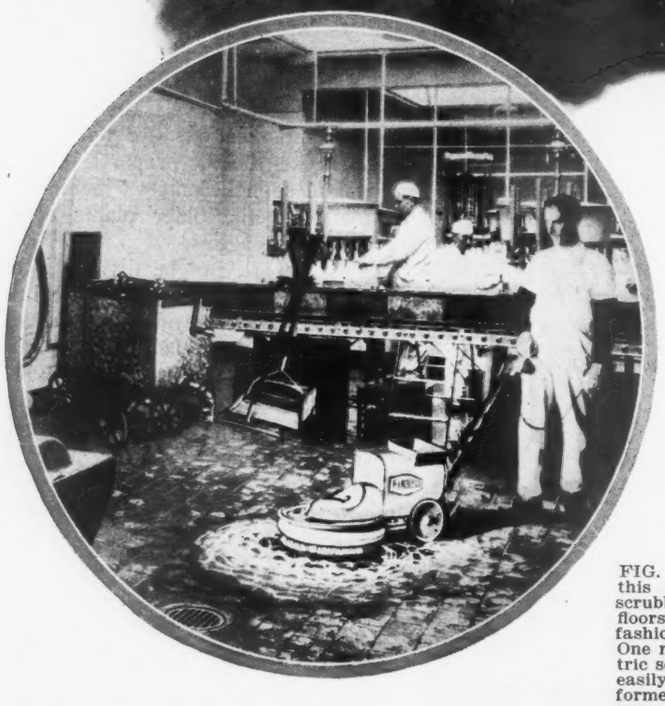


FIG. 2—COMPARE this new method of scrubbing and mopping floors with the old fashioned hand method. One man with an electric scrubbing machine easily does the work formerly done by a gang of several scrubbers.

Production and Pe
Both Benefit Fr
Good Plant H

By W. G. ZIEGLER, M.E.

PLANT sanitation has a very important influence on the health of men in a plant and inasmuch as production is dependent on the physical well being of the men, it is certain that healthy men will turn out more than sickly men. Also, trained men are a great asset and it is cheaper to keep them healthy than to break in substitutes when the regular men get sick. A clean, cheerful plant in which sanitation is carefully attended to, benefits because it draws the right type of men and keeps them efficient and on the job every day, and the men also benefit by having better general health. Keen managers are realizing more and more the importance of sanitation and are giving the matter the attention it deserves.

The requirements of the various City and State codes are often easily lived up to without having what might be termed first-rate toilet accommodations for the men. By doing more than is required in this direction it is possible to get and hold the better type of men mentioned above. This is especially true on hot, dirty jobs. If the men can take a shower bath at the end of the day, have individual steel lockers for their clothes, have good toilet facilities and cooled drinking water and be able to wash up in clean running water, they are better satisfied with their working conditions and they are more likely to stay well. Men who desire cleanliness are usually neater in their work and the influence of a clean plant makes them do neater work and keep their machines and benches clean.

The cleanliness of toilet rooms has such an important bearing on the health of the men that in large plants an inspector should be assigned to the task of checking up on the work of those doing the cleaning. All toilets, urinals and washbowls should be thoroughly cleaned at least once a day with a good disinfectant so that no disease germs will last very long.

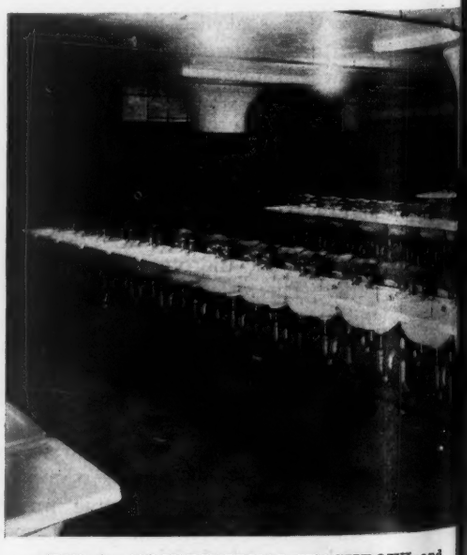


FIG. 4—AN INDIVIDUAL WASHBOWL and locker for every employee. The management recognized the value of good sanitation and

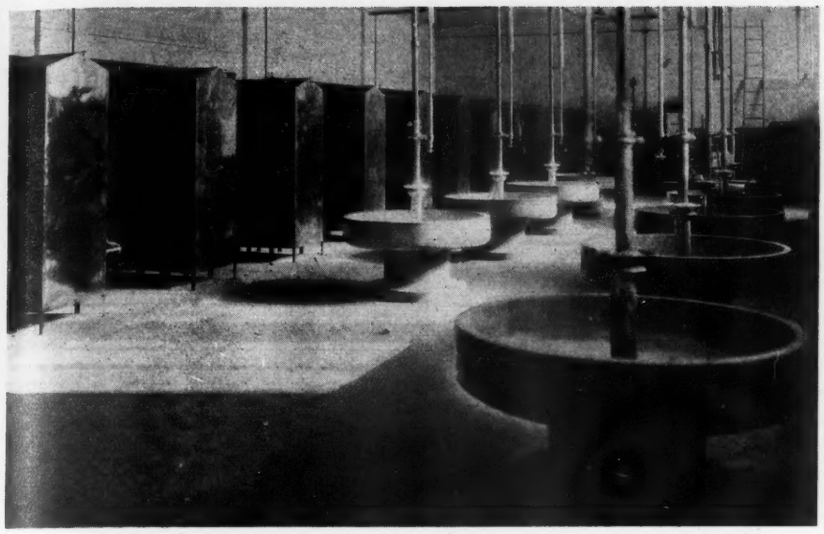


FIG. 3—A HANDY LOCKER and washroom where sanitation is well taken care of. The round wash basins save space and the men wash in a fountain of clean water. Note the full length steel lockers with sloping tops to prevent accumulation of rubbish on top.

Personnel From Housekeeping

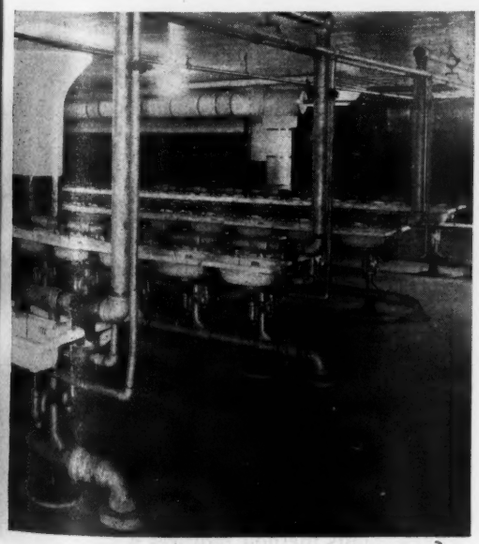
Toilet seats should be waterproof and sanitary and all toilets and urinals should be kept in good operating condition so that they flush clean every time they are used. Flush valves are now largely used, instead of tanks, because the valves are less likely to get out of order. The high stall urinal is much more sanitary than the smaller types that require marble, slate or vitreous panels at back and sides. These stall urinals are now made in groups to reduce the number of joints that might harbor vermin.

In the plant it is best to have steel toilet partitions because they are strong and durable and when they are well enameled they are easily washed. These partitions should be raised about a foot from the floor so that the floor can be easily washed. Walls of glazed tile and floors of tile or concrete sloped to drain are ideal in toilet rooms because they are so easily cleaned. Tile walls may be washed with soap and water or a cleaning compound and then rinsed with a hose if desired, and floors that have drains in them are easily scrubbed and rinsed with a hose.

Enough sinks should be provided so that the men can wash in clean running water at large sinks or in individual wash bowls, thus preventing the spread of disease. The large white enameled double sinks with a double row of faucets in the middle are very good if the men do not plug up the drain and wash in standing water. Some of the newer wash sinks are round to accommodate more men in a small space and these have a fountain of clean running water to wash in. Individual wash bowls are excellent, but the first cost of installation is high and they occupy more room than the other sinks if each washbowl is allotted to one man for

FIG. 5—A MAN-SIZED PAPER BALER does its part to reduce the fire hazards of loose paper and incidentally pay good dividends on the expense of baling.

* * *



has done everything possible to retain the health and increase the comfort of the men in the plant.

his individual use. Warm water should be provided at all wash sinks. This requires a mixing valve to regulate the temperature of the water automatically. In departments where the men get very dusty and dirty, shower baths should be installed and each shower should have a mixing valve for manually regulating the temperature of the water.

In order to have proper facilities for the men to store their clothes, most plants provide steel lockers at convenient locations. Steel lockers are sanitary and they prevent the spread of disease germs and also reduce the chance of a large fire due to spontaneous combustion of oily clothes, rags or waste. Where space is limited, double tier lockers may be used, but as most men wear long overcoats in the winter, the double lockers are too short and the men do not like them. Lockers may be of solid steel panels ventilated at top and bottom or they may be of expanded metal that allows free circulation of air.

Most workmen prefer not to have to carry bar soap from the locker room to the washroom and it is preferable for the management to furnish liquid or powdered soap. Liquid soap may be easily piped up from a central tank with a push valve at each wash basin. Bar soap that is used by one man after another is very unsanitary and should not be furnished in public washrooms because infections spread quickly from one man's hands to another on a bar of soap. Most plants furnish soap and paper towels in the office washrooms but the question whether or not to furnish soap in plant washrooms is dependent on local conditions.

FIG. 6—IN THE OFFICE WASHROOMS the appointments are a little nicer and in this plant liquid soap and paper towels are furnished.

* * *

Floors in every part of the plant should be cleaned on a regular schedule. In departments having screw machines and other oily machines the floors should be thoroughly scrubbed with a good cleaning compound once a week. The use of the proper cleaning compound makes cleaning easier as the oil and grease is readily removed if the cleaner if of the correct strength and composition. Wooden floors that are oil soaked constitute a real fire hazard in mill construction buildings and therefore should be kept reasonably clean to safeguard the investment in the plant. For hand scrubbing, stiff brooms or scrubbing brushes on long handles are used, but this method is being replaced in the larger plants by electric scrubbing and mopping machines that do the work of several men, thereby cutting down the expense. These scrubbing and mopping machines should be equipped with a long cable on a reel with an automatic rewinding device so that the cable will not be in the way of the machine.

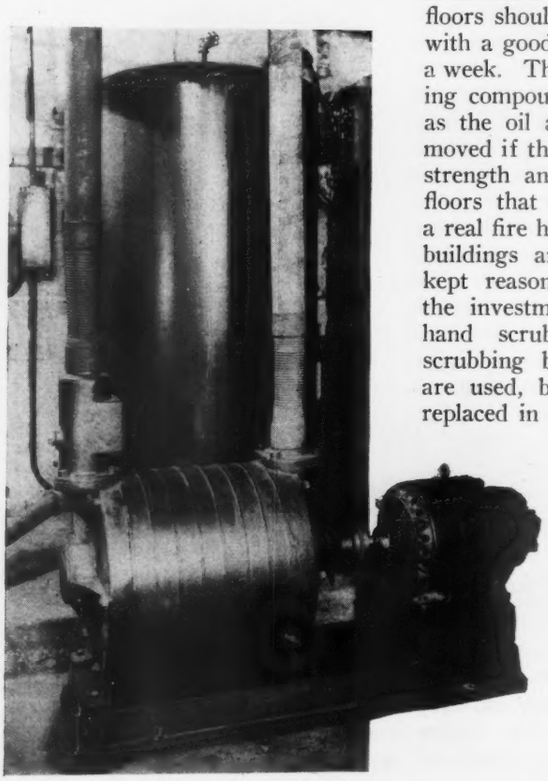


FIG. 7 — THE BUSINESS END of a stationary vacuum cleaning system, consisting of the exhauster and tank, can be located in the basement with vacuum pipes leading to conveniently located outlets.

* * *

Sweeping is ordinarily handled in small plants by the porters in the various departments but in the larger plants where cost of cleaning is given more attention, sweeping is usually done by sweeping gangs that work either during or after working hours. The foreman, in each department swept by these gangs, should sign a receipt that the floor has been swept to his satisfaction. In departments having heavy chips on the floors, stiff brooms are required. On dusty floors some kind of sweeping compound should be used to keep down the dust. Sawdust mixed with oil makes a good dust catcher. Concrete floors that were not properly finished when they were laid often keep on dusting and these should be hardened, painted or oiled.

Vacuum cleaning is replacing sweeping in some plants, especially where there is light dust on floors and equipment. Vacuum cleaning may be done during working hours because it does not raise any dust. Many new plants are piped up with vacuum outlets located at convenient points. This method requires a large stationary vacuum cleaning machine in the basement. In existing plants the portable electric-driven vacuum

cleaners are used and they have the advantage of not requiring any piping or installation. These portable outfits may be wheeled around the plant and their radius of operation is therefore larger than the stationary machines.

All machinery and equipment should be thoroughly cleaned and where possible wiped with an oily cloth just before closing time for the week-end. This prevents rusting of finished steel surfaces and gives the operators an opportunity of looking over their machines thoroughly in order to report any parts requiring repairs. These small repairs keep the machines in operation and avoid shutdowns when the machines are badly needed.

Oily chips constitute a fire hazard and they should be collected every day in special trucks and dumped into fireproof bins above the oil separators. The chips are then taken care of by the oil salvage departments. Machines that throw oil should be equipped with removable splash guards so that the floor will not become oil soaked.

Electric lamps and reflectors must be cleaned regularly to get the full benefit of the lighting system. Dust and grime collects on bulbs and reflectors in a short time and cuts down the efficiency very greatly. The correct time between cleanings is dependent on the amount of dirt and dust in each department, but in the cleaner departments the fixtures should be wiped off every few weeks and thoroughly washed every few months with soap and water or a good cleaning compound, being careful to rinse them well to remove any film to which dust would stick. The cost of cleaning should be taken into consideration compared with the cost of loss of light due to dirt accumulation. Good lighting helps to increase production and it pays to keep the lighting up to standard.

Windows should be kept clean in order to save lighting costs and to increase production. It is a well-known fact that production is increased with good lighting and day lighting is better than most artificial lighting. A regular schedule of window cleaning by men trained in this work is most economical. The men should be provided with light ladders and staging in order to clean inside and outside easily. Window cleaning compounds make the work easier. Where there are no shades or curtains on clear glass windows it is sometimes necessary to apply a coating on the windows to prevent glare.

Rubbish should be kept in fireproof covered cans and the cans should be emptied every afternoon. Departments in which a large amount of chips or scrap are produced should have this material removed regularly. Special trucks may be necessary for removing scrap, such as oily chips. Sometimes these chips may be dumped down into hoppers or bins from which the chips are sent to the oil separator and salvage departments.

Waste paper should be kept in fireproof covered cans and removed each day to a fireproof storage room where the paper is promptly baled. With a paper baler it is usually possible to get enough from the sale of the waste paper to more than pay for the cost of collecting and baling it.

Drinking fountains should be kept in good working condition and if circulating ice water is not provided the individual fountains should be iced every day, except in the winter. These fountains that require icing should be arranged so that the ice does not come in contact with the drinking water; the drinking water should flow through a coil at the bottom of the ice chamber.

Sanitation work has a large and important influence on the health and contentment of the men in the plant. Each foreman should be made to report, on a form provided for the purpose, any dirty or unsanitary condition anywhere in the plant and some method of inspection should be installed in order to check up on the work of the sanitation department. A prize for the cleanest department each month is often an excellent method of training the men to keep their department clean, thus aiding in the general cleanliness of the plant.

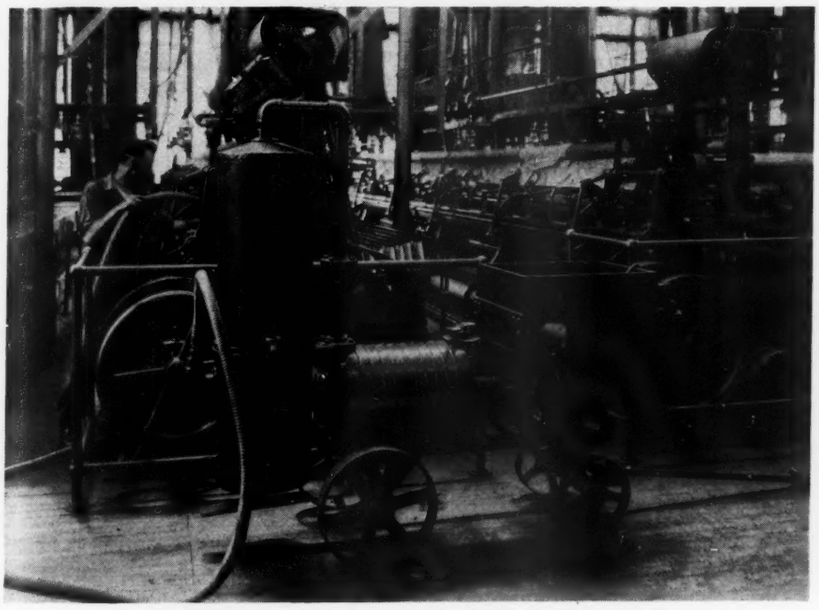


FIG. 8—THE HEAVY DUTY portable electric vacuum cleaner can be wheeled around the plant and its radius of action is limited only by the length of the electric cable. Light dust that cannot be handled in any other way is easily handled by vacuum.

* * *

A Power Bus From Scrap Material

A NEAT-appearing set of buses may be constructed by using an old knife switch for a standard. The switch used should have a capacity at least equal to the maximum current which the buses are expected to carry.

The blades of the switch should be removed and the slate base cut through the middle with a hack-saw, to make the two sets of standards. The buses, of suitable length, and made of copper bar should then be inserted in place of the blades and bolted securely to the six jaws.

Before making this last assembly it will be well to drill a number of holes through the three bars. These holes will serve later when one wishes to bolt lugs to the buses, and will save the necessity of awkward drilling on the assembly, or of taking down the buses for drilling.

The original connection studs of the switch will serve again to connect the buses to the current supply.

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Providence, Rhode Island.

How Motor Service Dictates Commutator Assembly

By Jesse M. Zimmerman
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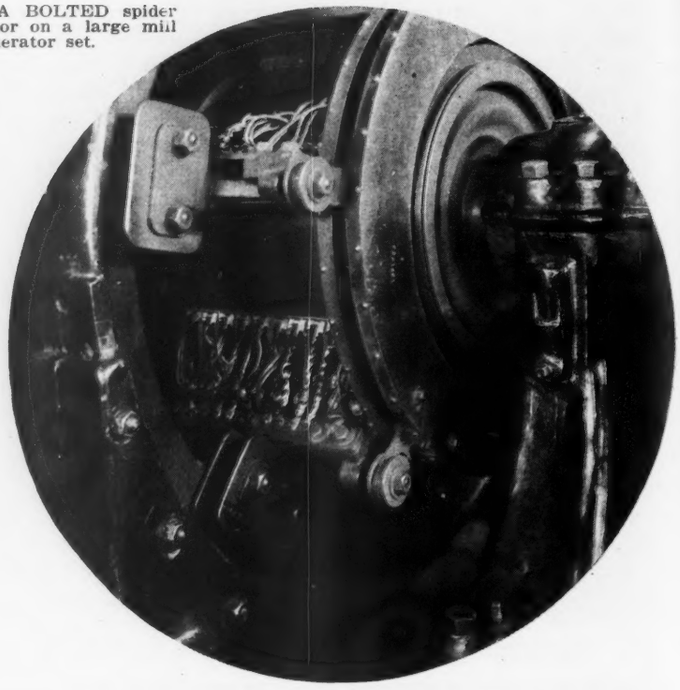

FIG. 1—A BOLTED spider commutator on a large mill motor-generator set.

COMMUTATOR constructions may be divided into two distinct classes according to the method of insulating the assembled segments. The first class, molded commutators, is particularly applicable to motors under ½ hp. The second class is the mica V-ring construction for insulating assembled segments and is the standard construction used in industrial motors.

Molded commutators have the copper bars and mica strips assembled in the usual manner, and held together in a mold, while a molding compound is forced into the V, and baked. This compound takes the place of the usual mica and steel V-rings.

Motors equipped with molded commutators are used chiefly for household appliances, on a.c. and d.c. machine-tool motors and similar applications where the motor is not subject to an excessive amount of metallic dust, dirt and oil. It is essential that the commutator be kept free from oil because a short circuit between bars or ground in the molded section cannot be repaired. Since the balanced design of the armature for fractional horsepower type of motors is such that the commutator, the winding and the shaft will last the same length of time, it is not desirable to replace or repair these commutators.

Mica V-ring insulated commutators can be sub-divided into different types of mechanical construction. This subdivision is made in accordance with the methods of holding the parts together, and it is as follows:

1. Riveted spider commutator.
2. Ring-nut spider commutator.
3. Bolted spider commutator.

A few of the small motors of the ½ hp. class or smaller, were designed to have two machined steel V-rings insulated with mica V-rings and held together by a spider. One end of the spider had a machined collar against which the rear metal V-ring fitted. After the commutator had been assembled and pressure was applied to the front metal V-ring, the front end of the spider was expanded. This held the assembled segments together. This type of construction had the advantage of mica V-ring insulation, but it was handicapped with the disadvantage that a ground or short circuit between bars could not be repaired. Therefore, this type of construction is no longer used on this size of motor. In many cases these commutators have been replaced by ring-nut spider commutator nuts.

The ring-nut construction is used on commutators up to approximately 13- to 15-in. gage diameter. However, the bolted and ring-nut commutators are both used on commutators ranging from 7- to 15-in. gage diameter It is just as rare to find a bolted design below 7-in. gage diameter as it is to find a ring-nut above 15-in. gage diameter. It is very difficult to give a rule for determining, just when the bolted type of construction should be used and when the ring-nut type of construction should be used.

The ring-nut commutator shown in Fig. 2, consists of a spider, a front detachable metal V-ring, and a ring nut. We usually think of this type of construction as having the spider and the rear metal V-ring in one casting. This is usually true, but there are some cases where it is found very desirable to have the armature spider serve as the commutator spider

In this, the fourth article of a series on commutator assembly and repairs, the author points out the advantage and disadvantages of the riveted, ring nut and bolted spider commutators for the distinct service they are to perform. The first article, which appeared in the December, 1926, issue, Industrial Engineer, dealt with mica selection. The second article covering commutator bar selection appeared in the April, 1927, issue, Industrial Engineer, and the third article on the assembly of segments appeared in the December, 1927, issue, Industrial Engineering. The fifth article will appear in an early issue.

as in Fig. 3. This permits a smaller diameter commutator which decreases the peripheral speed, thus giving better commutation and the weight of copper which decreases the centrifugal stress of rotation as well as lowering the cost of the commutator for this type of machine construction.

With this type of spider it was found impractical to cast the rear metal V as part of the armature spider for two reasons:

1. If the rear V-ring was cast as part of the spider, the punchings and end plates had to be placed on the spider from the rear, which necessitated the placing of the retaining nut at the rear of the armature. Experience, however, has shown that the punchings can be assembled easier and kept tighter by having the retaining nut at the front end of the armature core. This applies especially to armatures which are in extremely heavy service such as crane and mill motors, and not to smaller types of motor armatures.

2. Casting the rear metal V as part of the spider was also considered undesirable because a ground in the rear of the commutator would burn a large hole in the metal V, thus making it necessary to replace the armature spider. For this reason the rear metal V-ring was detachable, its bore being such that it could slide over the body of the spider and fit against a shoulder. This same type of construction has been used successfully on ring-nut commutator where the commutator spider is separate from the armature spider.

In a similar design the same result was obtained by tapping the rear metal V-ring while the rear of the commutator spider was threaded. The metal V-ring was then screwed to the spider after which it was doweled in place. This type of construction has fallen by the wayside because the cost of manufacture was too high and it was also necessary to supply a complete spider when it was only necessary to renew the rear metal V-ring. Therefore, no real advantage could be claimed for this type of construction.

One can always find a disadvantage to every design. Some operators feel that the ring-nut commutator is more difficult to assemble as it is necessary to apply pressure (from an external press) to the front metal V-ring to keep it from turning, for should it turn with the ring nut the assembled segments would in all probability become skewed. It is essential to apply this external pressure to the detachable metal V-ring on all types of industrial commutators to make them tight. Unless this is done it will be necessary to retighten them at regular intervals after the motor has been put in service during the curing process.

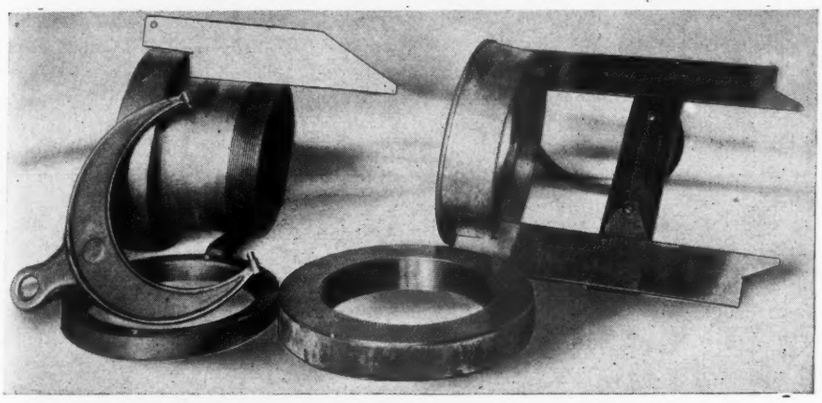

FIG. 2—DETAILS of ring nut spider commutator for a 514-B commutator with the necessary gages for machining and measuring the different parts. The body is measured with a snap gage. The V is measured with a spider gage so laid on the body that the 3-deg. and 30-deg. angles of the V will fit into the V of the gage.

* * *

The bolted type of commutator has many advantages. It is possible to design a ventilated spider without materially increasing the diameter of the commutator. In reality, it is easier to assemble a commutator of this type because the skewing of the bars will not be prevalent. A very simple ratchet wrench can be used to tighten the bolts when the commutator is in place. This type of construction may be sub-divided into three classes, each having a distinct service to perform. They are:

1. The front detachable V-ring for industrial and railway service.

2. Rear detachable V-ring for special railway service.

3. Front and rear detachable V-rings for large diameter power generators and motor commutators.

The front detachable V-ring combination is used exclusively on industrial motors, such as crane and mill types. It is simple to assemble and easy to repair any short circuits or grounds when they occur in the front metal V-ring. The commutator bushing consists of a spider with a rear metal V-ring cast to it, a front detachable metal V-ring and the holding bolts as in Fig. 4.

With this type of construction it is necessary to machine a groove in the front of the spider. This groove should be filled with lead by placing a lead ring in the groove and swedging it into place. This is necessary in order to keep the oil from entering the commutator at this point. If the commutator is placed in an upright position, the groove can be filled with molten lead. After it is cold it should be swedged to make sure that the joint

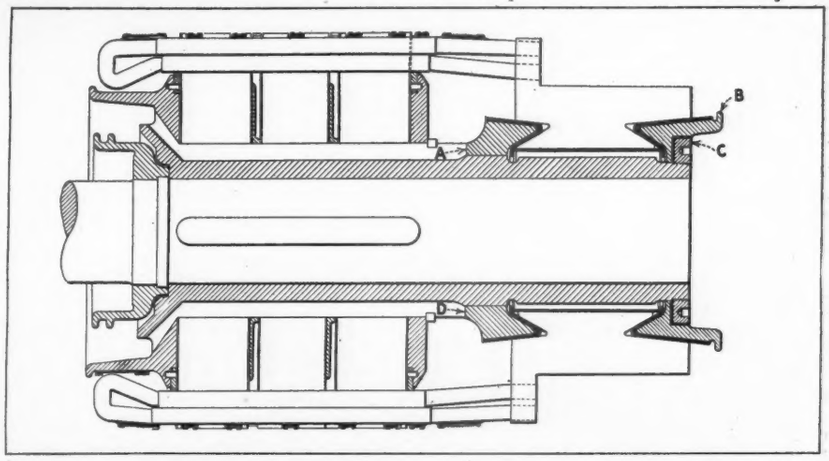

FIG. 3—ARMATURE SPIDERS also serve as commutator spiders. This permits a smaller diameter commutator which decreases peripheral speed and gives better commutation. This type of spider is shown here. The rear metal detachable V-ring is shown at A, the front metal detachable V-ring at B, the commutator ring nut at C and the shoulder against which the rear metal V-ring rests at D.

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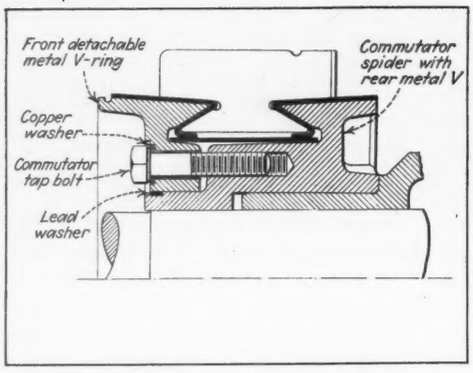


FIG. 4—BOLTED SPIDER commutator with front detachable metal V-ring. This type is used on crane and mill type motors due to the ease of assembly and repair.

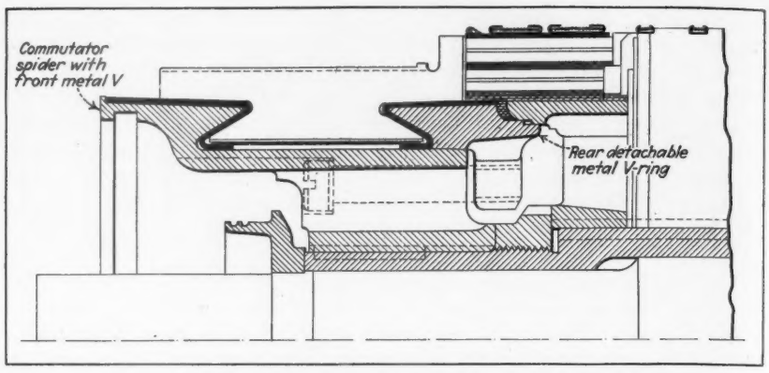


FIG. 5—BOLTED TYPE commutator with rear detachable metal V-ring. This type is used on railway motors where the length and breadth of the motor is limited to the space in the locomotive truck. Increased mechanical strength is characteristic of this type.

* * *

is tight. The general practice is to place a copper washer over the bolts next to the detachable V-ring to make an oil-tight joint at this point.

Rear detachable V-ring commutators are used on railway motors where the length and breadth of the motor is limited to the space in the locomotive truck. It is necessary to have a large over-hanging front metal V-ring to provide sufficient room for the hub of the bearing to extend toward the armature to obtain the required length for the armature bearings. It is a very good design to cast the front metal V as a part of the commutator spider, thus making the rear metal V-ring the detachable member. This detachable V-ring has eight or more tapped holes for the commutator bolts, the spider body being drilled for the bolts to pass through. This design, shown in Fig. 5, in addition to increasing the mechanical strength lends itself to an increase in size of ventilating ducts without increasing the diameter of the commutator.

This type of construction is used on large diameter commutators such as rotary converter, d.c. generator, and large reversing mill motors. The complete commutator consists of a spider and two detachable metal V-rings. These rings fit over the spider body and are held in place by through bolts as shown in Fig. 6.

Bolt breakage sometimes occurs on bolted types of commutators, but usually it can be traced to faulty methods of assembly, such as: bolts being too long, or not applying pressure to the detachable V-ring.

Bolts Being Too Long—Sometimes the bolts are too long allowing them to strike the bottom of the hole before the commutator is tight. In this manner the bolt is twisted and weakened and is often broken during the assembling operation. If it does not break in the assembling operation, the remaining bolts are subjected to an overload because it does not take its share of the load. This occurs on the type of commutator shown in Fig. 4.

Not Applying a Pressure to the Detachable V-Ring—It is often the practice to tighten the commutator without applying pressure from an external press to the detachable V-ring. Commutators of smaller diameters are designed to be tightened under pressure. If they are tightened without this pressure the bolts are liable to twist during the tightening operation thereby becoming weakened so that they are likely to break in service. When a bolted type of commutator is tightened without pressure, a snap wrench should be used which will be set to trip at a pressure and operated at a leverage specified by the manufacturer of the commutator.

Whenever bolt breakage has been experienced, it is desirable to use a special bolt, as in Fig. 7, which has a section of the body between the head and the end of the threads machined $\frac{1}{6}$ in. smaller in diameter than the diameter of the root of the thread. The twisting action due to the tightening operation will be distributed over the small diameter section of the bolt and will not be confined at the end of the thread. Furthermore, any elongation due to the expansion while the commutator is in service will be distributed over the small diameter of the bolt. When machining the bolts, it is necessary to have a bearing surface near the head to hold the V-rings in place.

The accuracy of machining is the most important part of any commutator, as the mechanical stresses can be taken care of by changing to metals which have higher mechanical strength.

The first machining operation on the spider is the surfacing of the out-

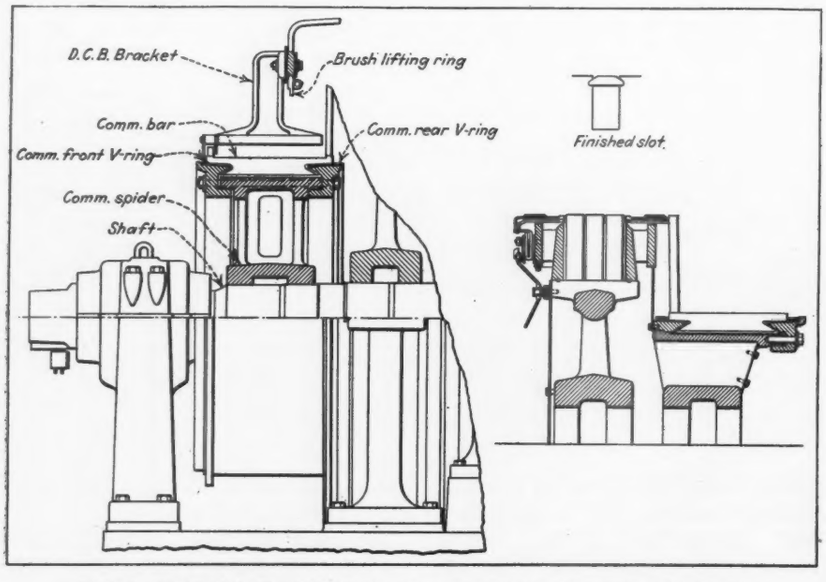


FIG. 6—SECTIONAL VIEWS of rotary converter spiders with both front and rear detachable V-rings. The one at the left is held by through bolts and the other shown at the lower right is held by stud bolts.

side diameter of the body. This surface must be machined to a very accurate dimension as it is from this surface that the attached metal V is machined and gaged. The body is measured by a snap gage as shown in Fig. 2. The V is then machined and gaged by a spider gage in the following manner. The straight edge of the spider gage is laid upon the body so that the 3 deg. and 30 deg. angles of the V will fit in the V of the spider gage. The depth to which the V is machined is measured from the intersection of the extended side of the 3 deg. and 30 deg. angles of the gage to the rear of the spider by a steel scale. It is very important that the depth of this V be machined accurately for the rear V must accurately locate the assembled segments with respect to the brush face.

The detachable V-ring must fit over the body of the spider with an "iron-to-iron" fit. Therefore, it is important that it must not have any more clearance than is necessary for it to slip along the body during the assembling process of the commutator, as this will prevent any radial movement of the detachable V-ring, and it will throw the commutator out of line.

The 3 deg. and 30 deg. angles must be machined accurately as well as maintaining the proper gage diameter. A special female bridge gage is made to determine the accuracy of the angles and the gage diameter.

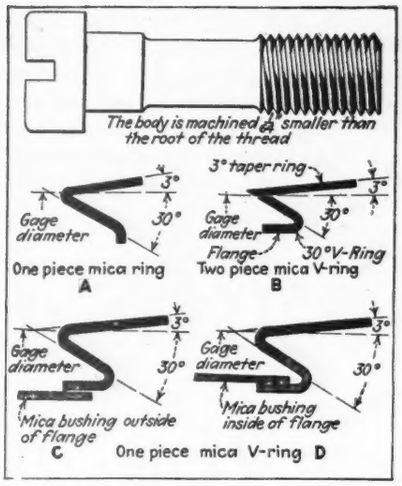
The mica V-rings differ from the mica strips in bond characteristics. Mica plate used for making V-rings must be made with a bond which is not completely seasoned. The ring must remain plastic to a certain extent in order to give a yielding effect to the commutator when it passes through alternate cycles of heating.

The shape and size of a mica ring is a very important feature in a commutator. The mold upon which it is made must confirm accurately in dimensions to the steel V. If the mold is too large the outer surface of the molded V-ring will wrinkle between the bars, leaving an opening. If the mold is too small, the V-ring will break when the commutator is assembled.

Mica V-rings were originally made in one piece the shape of a V. This type of ring, Fig. 8*A*, is still used on low-voltage motors. It did not give sufficient creepage distance from the commutator to the spider for motors above 500 volts. By making a flange on the ring the creepage distance was greatly increased. But, at this stage of development it was impractical to mold this type of a ring at a reasonable cost. This led to the development of the two-piece ring as shown by Fig. 8*B*.

The two-piece mica V-ring consists of a 3-deg. tapered bushing and a 30-deg. molded V-ring with a bent flange. The longer the flange, the greater was the creepage distance. The copper V's are machined with a groove at the bottom of the V to allow an opening for the joints of the two rings when the commutator is being assembled. Theoretically, the joints of the two rings make a perfect seal. On high-voltage motors this joint does not permit a large enough creepage distance. Some trouble has been experienced with grounds at this point, and this led to the development of a one-piece mica V-ring as shown in Figs. 8*C* and 8*D* with a flange, which is being used on all 500-volt motors.

In molding mica V-rings of this type, fingers are cut to enable the mica to be molded around the bends



FIGS. 7-8 (ABOVE)—A commutator bolt designed to eliminate breakage. When machining the bolts, it is necessary to have a bearing surface near the head to hold the V-ring in place. (Below)—Mica V-rings were originally made in one piece as at A. This type is still in use on low-voltage motors, but insufficient creepage distance from commutator to spider for motors above 500 volts led to the development of the two-piece ring as in B. Subsequent trouble led to the development of the one-piece rings with a flange as shown at C and D for use on 500-volt motors.

* * *

of the flange. Several layers of these strips are accurately staggered in order that the openings between the fingers will be covered by the next layer.

The two-piece mica V-ring was easier to make in small sizes as it was molded from a mica plate which was the exact thickness of the finished ring.

For large diameter commutators it is impractical to mold the mica V-ring in one complete unit. Therefore, it is molded in sections, each being $\frac{1}{32}$ in. thick. The complete ring consists of two segmental rings, the joints of the first ring being covered by overlapping with the second ring.

The photographs shown in Fig. 9 are of two mica V-rings, which had been in the same commutator, heated to 150 deg. C. and assembled with 25 tons pressure. The opening around the flange of the rings was sealed with black paper and a 500-watt lamp was placed back of each V-ring to keep all direct light of the lamps from the picture, showing only the light which penetrated the mica V-ring. The views were taken looking directly at the 30-deg. face of the rings. The mica V-ring which has a light circle shows clearly where the pressure of the copper and steel V squeezed the bond out of the mica. The light color shows that the thickness of the ring has been reduced by the bond and mica shifting. At one point, the

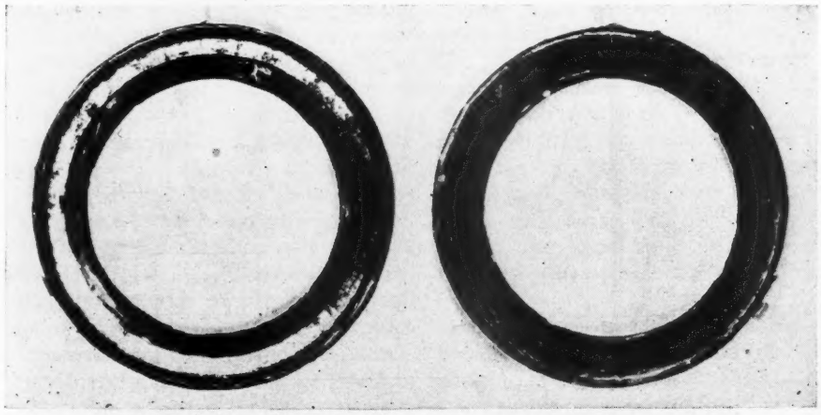


FIG. 9—PHOTOGRAPHS made of two mica V-rings which were placed in a commutator under identical conditions of temperature and pressure. The ring with the light circle shows where the pressure squeezed the bond out of the mica reducing the thickness of the ring. The other ring at the right shows no light at all.

mica in this ring was less than 0.010 in. thick. The other ring shows no signs of light at all. Important features of the mica V-ring follow:

1. Accurate staggering of fingers.

2. They must be made of a bond which will not squeeze out under pressure.

3. They must be made of a bond which will soften when the commutator is heated, so that the ring will be plastic.

4. The ring must be the same size as the steel V-ring so that the mica will not wrinkle.

5. There should be no slippage of mica ahead of the copper or the V's.

The mica bushing for the arch-bound and V-bound commutators is probably the least thought of in a commutator, yet it has a very important function to fulfill. In order to decrease the diameter of a commutator it is essential that the commutator bars fit close to the spider. By placing an insulating bushing over the spider the distance between the segments and the spider body can be made smaller. Where it is not necessary to decrease the diameter of the commutator this bushing is omitted on the 110-, and 220-volt commutators and on some 500-volt commutators when the motor is not subjected to undue moisture and dirt conditions.

How Armco Uses Safety Flags

IN EVERY Armco plant where maintenance is carried on under all kinds of conditions some form of protection is provided for the safety of those concerned. All plants, however, do not use the same means of getting results.

For some time the Ashland, Ky., plant followed the system instituted by the electrical department at Middletown, Ohio, in using fiber markers to indicate danger, open switches, etc., but if someone needed fiber for reasons known only to himself, the marker would disappear. This led to the adoption of departmental flags with the following rules and regulations for their use throughout the plant.

The blue flag is a symbol of safety, and when placed on an electric disconnecting switch, steam or hydraulic valve, or other electrical or mechanical controlling device indicates:

1. The equipment is undergoing inspection or repairs.

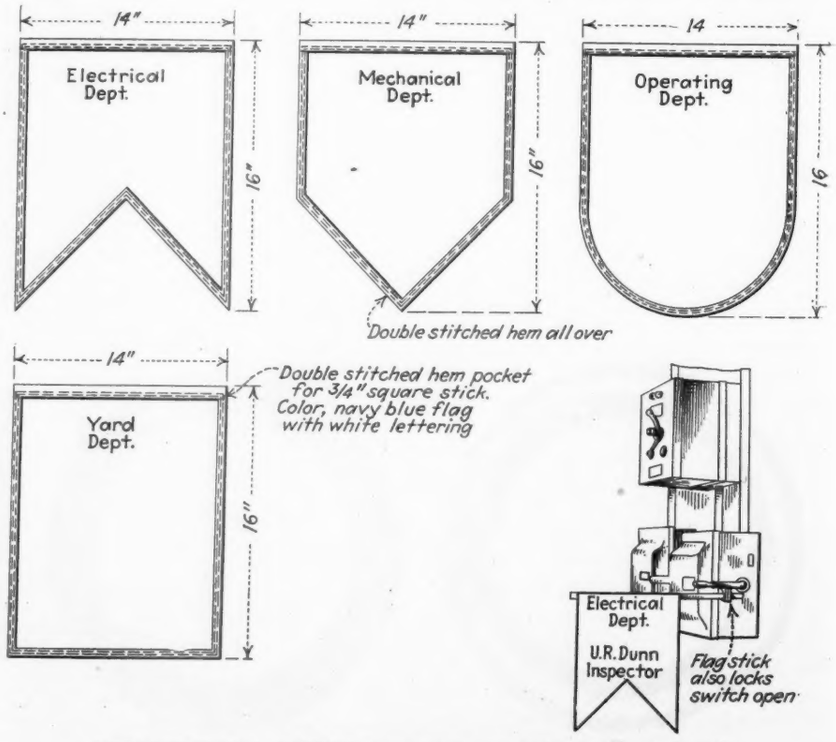
2. A fellow workman might be endangered if it is moved.

3. The controlling device or machine should not be moved until the flag has been removed by the man who placed it there.

Safety flags, bearing the owner's name and department are assigned to each motor inspector, millwright or pipefitter and their helpers, to each maintenance foreman, to the leader of each group of maintenance men, and to the foreman in each operating department, and to such others as may be designated by their superintendent. They are to be carried by the individuals to whom they are assigned, when on duty and who must be prepared to show them on demand if they are not in use.

Safety flags are to be securely attached to the inclosed disconnecting switch or other positive controlling device of any piece of operating equipment undergoing inspection or repair, by the man or men in active charge of that particular job. If men from different groups or departments are working on the same machine, the leader of each group must attach the flag of that group. As fast as one group finishes its work the flag of that group should be removed by the men who placed it. If the repair job extends over a turn, the flag first placed remains until replaced by the safety flag of the group taking over the job.

When a safety flag is once placed it should not be removed by any one other than the man who placed it there if it is physically possible for him to do so without delaying production. Forgetting to remove a safety flag after work is finished is a serious matter, as it may interfere with production. If it is not physically possible for the safety flag to be removed by the man who placed it there, it may be removed only by direct order of his foreman or superintendent or assistant superintendent and then only after a competent man has inspected the machine and declared it safe.



DEPARTMENTAL SAFETY flags for the protection of men and equipment at ARMCO. Each flag bears the owner's name to whom it is assigned, and it must be carried by that individual. Usually, the flags are carried in the pocket as one would carry a handkerchief. Light harness snaps facilitate attachment to the equipment. The lower right sketch shows the position of the flag with a staff when in use.

Adapting Standard Equipment to

Special Problems In Handling Materials

By E. J. TOURNIER
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Robins Conveying Belt Company,
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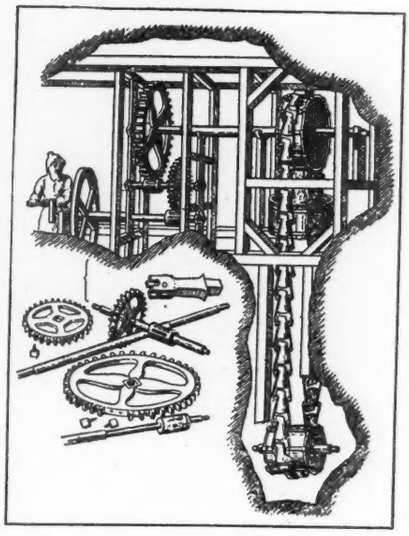
UNTIL the last five years, manufacturers of pottery, sanitary ware and porcelain have hesitated for various reasons, to install materials handling equipment. Some have said that their problems were different than those of other industries; that their products were too fragile or that mechanical handling would prevent proper setting of the glaze, etc., etc.

The ceramic industry is one of the oldest in the world and its customs until recently have clung to it like a potter's topknot. Most large plants today use such modern equipment as filter presses, dippers and glaze sprayers, but they still use hand labor in loading and handling fragile ware between presses and kilns, and from kilns to the glazing room. This situation is difficult to reconcile with the fact that in the earliest recorded use of conveyors, the potter's art contributed much to the successful operation of these machines. One of the first known bucket elevators known as a Chain-of-Pots, dating from the year 1550 A. D., was made up of two strands of metal chains with earthen ware pots fastened at intervals. The pots were made by hand on the potter's wheel, and the chains were primitive blacksmith work, but the elevators possessed the virtue of being functionally operative.

The demand of the present day markets for goods, however, requires that the methods of handling as well as of manufacture, shall be adequate. It is a natural consequence, therefore, that investigations should be made to ascertain whether or not modern conveying equipment is applicable to the problems of the ceramic industry. A few results of cases on record will serve to indicate how the situation has been met through the use of well known forms of equipment.



PRIMITIVE BUCKET elevator (1550 A.D.) from which modern chain conveyors and elevators are derived.

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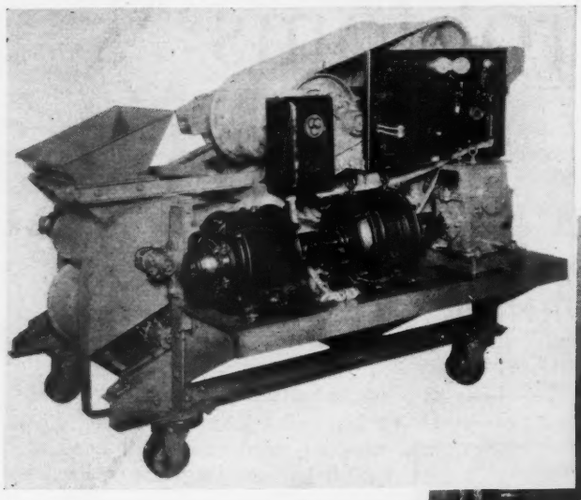
In the manufacture of pottery, tile and sanitary ware there are two principal divisions in the materials handling problem. The first has to do with handling raw materials into the plant and to the various processes; the second relates to the transfer of goods in process between operations and to the handling of the finished product. In the former case, machinery is required to handle bulk materials such as clay, sand, cement, gypsum, etc., while in the latter case, packed or generally cubical solid shapes must be handled. This requires an essentially different type of equipment.

Since most of the mechanical handling equipment will need to be adapted to existing plants, local conditions will determine to a great extent, the type of apparatus to be used. For example, if in a given plant, extensions have not been planned in relation to materials handling, it will be practically impossible to use any system of inexpensive straight-line conveyors. The equipment will require sufficient flexibility to be independent of the fixed channels of travel such as limit chain or belt conveyors, monorail conveyors and the like. In these cases self-propelled transport units such as tractor trucks and platform trucks, each with a labor attendant, will be the most practical solution.

It will be found in the construction of new plants, however, that mechanical conveyors for handling raw materials and goods in process will result in the lowest handling costs, if they are incorporated in the original plans. For handling the finished product where the service consists mostly of placing goods in storage and withdrawing them, a mobile type of equipment is best fitted to take up the load wherever it may be located and transfer it to any desired destination within the plant. The ability of elevating platform trucks and portable elevators to accomplish this result is especially useful in stacking pottery, sanitary ware, etc., in drying sheds or store rooms and in removing the articles from storage to cars or trucks for shipment. Equipment which is restricted to fixed paths of travel is obviously not as well suited to service of the character just mentioned.

Clay and sand are the principal raw bulk materials to be handled in

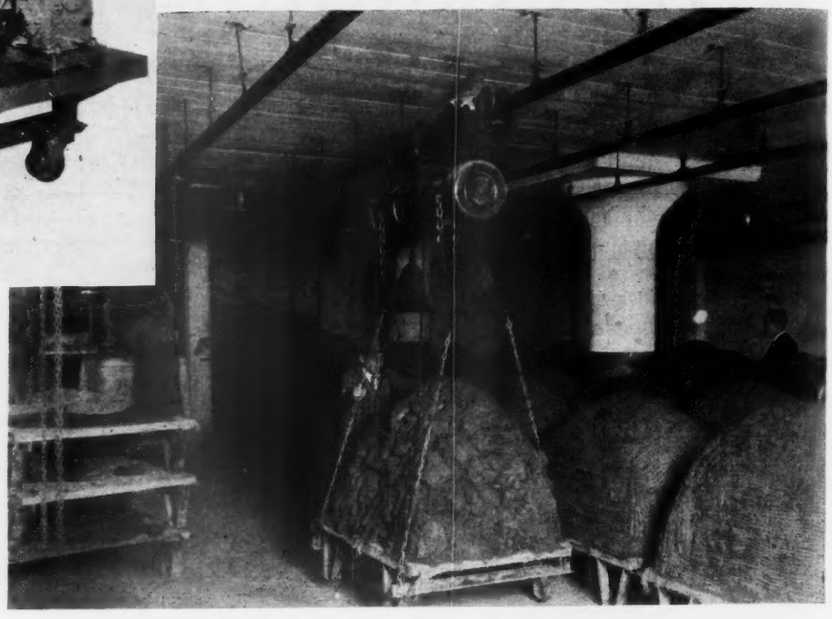
quantity. In most cases they are received in hopper bottom cars, although sometimes clay which must be kept dry is received in box cars. Unloading the cars of the various clays therefore, requires a different type of equipment, depending on the kind of car.



A BELT CONVEYOR with magnetic head pulley, used in removing iron particles from ground clay, to prevent rust spots in porcelain. This machine is complete with motor generator set.

In unloading either sand or clay from bottom dump cars, a track dropper with either a reciprocating feeder or an apron feeder is used to draw out the material at a uniform rate. The feeder in turn discharges on to a belt conveyor which transfers the sand or clay to overhead storage bins.

Where the clay is to be used for fine work, as in the manufacture of china ware, it must be ground and screened, after which impurities of a ferrous nature must be removed. This is necessary in order to prevent rust specks in the finished product. For this purpose it is customary to use a magnetic belt separator. Transferring wet clay from the mixers to the moulding room is a difficult handling problem on account of the nature of the material, which is sticky and adheres to the surfaces of belts, rollers, or other forms of conveyors. The usual practice is to pack the clay by hand on boards about four feet square, into a pile about two or three feet high. The boards and their loads can then be lifted either by chains and a monorail carrier or by means of platform trucks. In the latter case the clay boards are made in the form of skids which can be lifted by the elevating platform of the truck. Elevating platforms are frequently used also for elevating clay to the top of wet grinders. For this purpose the platform is fitted with a structural steel frame which carries a 20 cubic foot weigh bucket. When in position at the level of the grinder, the bucket is discharged by tipping. One operator with this equipment, supplies and weighs materials for two grinders at a pottery in Los Angeles, Cal., where in one year it has earned over $2,500.



WET CLAY presents a special problem in handling, because of its adhesive qualities. Piled on boards, it is here being handled by overhead trolley and hoist.

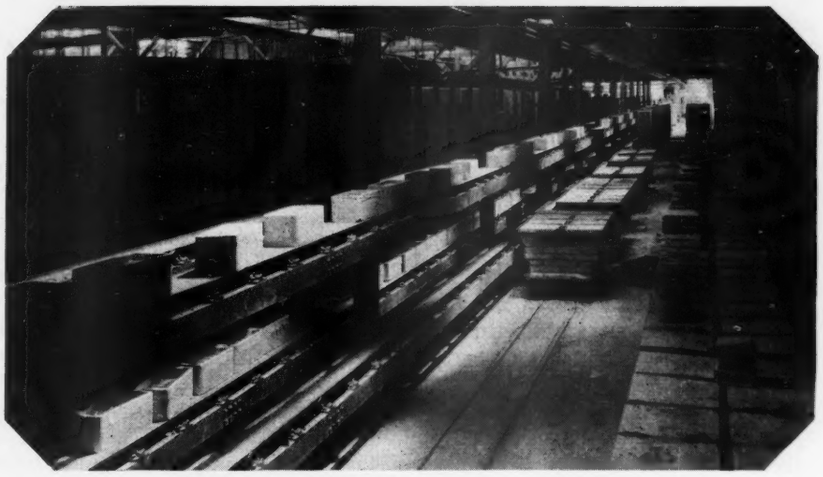
ANOTHER METHOD of handling wet clay; by means of skid platforms and lift truck. This is suitable where flexibility is required or where straight-line conveying is not adaptable to local conditions.

A great deal of the ware made in ceramic plants presents unusual problems in handling mechanically the finished goods. The transfer of such articles involves more than just carrying objects from one place to another. In some cases the application of machinery has been long delayed because of the belief that the goods were too fragile or that the glaze would be disturbed in handling semi-finished ware. Improvements in the design of equipment and increasing knowledge of the requirements have brought about applications of mechanical handling devices not thought possible ten years ago. Where the belief existed that mechanization held little of practical value to the ceramic industry on account of the difficulties in its application there is now a growing conviction that mechanical handling pays dividends. As an example may be cited the experience of a plant manufacturing wall tile, in Zanesville, Ohio.

This company was faced with the problem of increasing its production one-third in a limited space, while at the same time certain technical conditions were to be met. The principal points to be considered were

the following. Green tile in saggers must be carried without jarring or breaking; freshly dipped tile must be carried to kiln cars without rubbing; the conveyor must carry warm saggers from the kiln cars; the complete conveying system must handle 9,000 saggers in an hour, and the entire installation be reversible.

In order to meet the new product schedule, six lines of belt conveyors were installed to replace a force of 30 men hauling saggers between the presses and the kilns in two-wheeled carts fitted with elliptical springs. The carts were large and heavy and their operation required space that was needed for the construction of two new tunnel kilns. The elliptical springs on the carts prevented much breakage, but the system was slow and cumbersome.



TWO BELT conveyors, one above the other, handling saggers in a wall tile factory. Economy of space dictated the use of narrow frames and brackets on the columns, instead of the usual frames extending to the floor.

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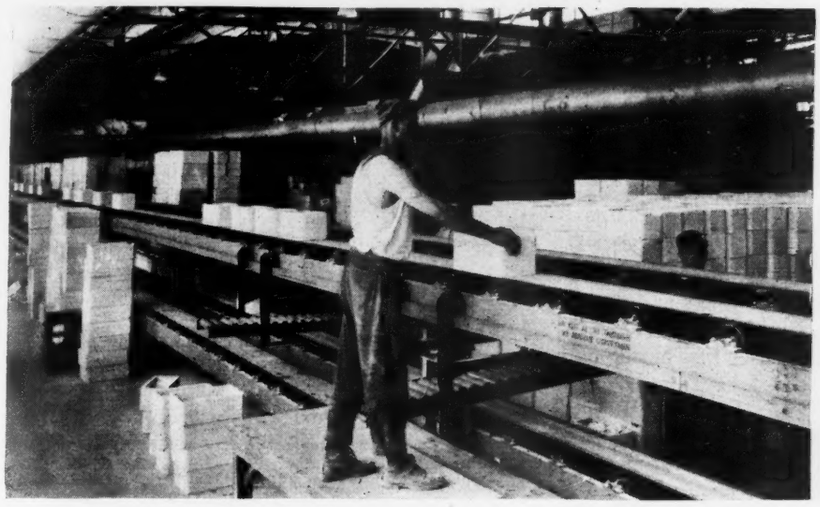

ANOTHED VIEW of the sagger conveyors in the previous illustration. Conveyors are reversible, to permit conveying to either end of the building. Short sections of gravity roller conveyor facilitate transfer of saggers from one top belt to the other.

* * *

Two additional kilns were now to be served, making a total of eight, an increase in the number of carts would have congested the traffic lanes thereby slackening production.

The needs of the plant were met by the six belt conveyors, the use of which for handling saggers is the most recent advance in the ceramic industry. The chief mechanical problem was to design a conveyor that would carry a heavy load of saggers. Two conveyors each 457 feet long are arranged one above the other. Saggers are carried from presses to kiln cars and from kiln cars to glazing room on the top belt. Empty saggers are returned from glazing room to presses on the lower belt. The belt conveyors handle as many saggers as could be moved by 50 men with trucks. What is of equal importance is that the conveyors take up but little room, and overtime work has been eliminated.

Production has been increased 33⅓ per cent without additional expense for labor.

A ceramic plant in Chester, W. Va., had, in addition to the question of increasing production, a serious problem in the matter of losses due to breakage of chinaware handled manually. After some investigations of the results obtained in other factories, it was decided that a system of belt conveyors would solve both problems.

The ware is first moulded and dried, preparatory to the first firing. It is then placed in saggers, loaded on transfer cars and passed through a tunnel kiln. After the goods have been baked in the kiln, the cars are withdrawn and allowed to stand for the purpose of cooling the china ware.

An inclined belt conveyor with its loading end located near the floor of the work room is loaded by hand and delivers the ware to a second conveyor extending at right angles to the first. This second conveyor delivers to the inspection room.

In all of the instances cited, it will be noted that no new devices have been used. It has been, rather, that after thorough demonstration of their adaptability to the cases in question, well known and tried forms of conveying equipment have solved handling problems which plant managers thought could only be met by manual operation.

BELT CONVEYOR used in the inspection room of a chinaware factory; part of a system installed to reduce breakage, and which was found also to cut handling costs.

* * *

The PLANT ENGINEER'S

Conducted by F. M. GIBSON, *Consulting Editor*
Plant Engineer at American Sugar Refining Company

A MANUFACTURER of rubber goods in Eastern Massachusetts is conducting an experiment in production that is being watched with a great deal of interest. There are some departments in which production is purely mechanical and these departments have been placed under the jurisdiction of the industrial engineer. A single instance is not sufficient to prove the success or failure of the principle involved as much depends upon the personality and capability of the engineer in charge. There are many points in its favor. It should result in more discrimination in the selection and more intelligent instruction of operatives. It should lead to less abuse of equipment and less waste of heat and power. Being in closer touch with the operation of the machines the engineer has a better opportunity to follow closely the maintenance problem and to study the possibility of improving the equipment and the effect of temperatures, pressures and speeds upon the quality of the product. The element of doubt comes in the co-operation with other departments responsible to a different department head. The division of production under two separate heads is not always desirable. In this particular instance the engineer is very capable and I believe will be successful.

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PIECES of equipment often seem to possess some of the traits of the human race. Placed in some obscure location, they perform their work efficiently and quietly and are almost forgotten. The other day a conveyor belt salesman quoted as a startling performance the number of tons per foot that one of their belts had conveyed before it was worn out. A few days later there was proposed the relocation of a certain conveyor belt. No one knew off hand the age of this belt and when the records showed that it had been installed years ago I had the curiosity to figure the tons per foot conveyed by this belt. To my astonishment the figure was 10 per cent higher than the record of which the salesman boasted and the belt is still in good condition. Two years ago I had occasion to test the load carried by a 10-hp. motor in a campaign to improve power factor. The motor had been in operation for eight years working on an average of 304 days per year and 24 hours per day. The equipment being driven was in good condition and alignment and the motor had given no trouble. The motor carrying a load of 16 hp. and had apparently done so since its installation. How many interesting records one might find by investigating these old pieces of equipment that are so quiet that their existence is almost forgotten.

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THE industrial engineer of a neighboring plant tells me that in one day he hired four good mechanics but was compelled to get rid of them as a physical examination revealed that one had heart trouble, another had hernia and the other two showed symptoms of tubercular condition. This illustrates the value of physical examination of employees which is being rapidly adopted by industrial concerns due to the increasing severity of accident compensation laws. While it provides protection to the employeer, it indicates a future economic condition which the engineer should have his share in solving. When the larger concerns refuse to employ hazardous employees, these employees will necessarily seek employment in the smaller plants until these plants will be compelled in self defense to adopt the same protection. This condition is approaching more rapidly than most people realize. How will this class of help support themselves? Will there be a special set of compensation laws for them? What is your solution?

* * * *

WITHIN the past month I have had two experiences that will serve as good illustrations. The manufacturer of a patented machine wanted six weeks delivery on a repair part and at a very high price. I had a pattern and a casting made and machined the casting all within a week. The cost of the repair part, including overhead, was 60 per cent of the amount asked by the manufacturer and the cost of the pattern was 40 per cent of my total cost. The manufacturer had the advantage of possessing the pattern, special machine tools, jigs, experienced machinists and quantity production. Having the pattern on hand this repair part will cost in the future only 35 per cent of the manufacturer's price. The other instance was one where only one small part was required but the manufacturer would sell only an assembly of five parts, four of which were not required. In this case I made the part required at 15 per cent of the cost of the assembly demanded by the manufacturer.

This is not a wholesale condemnation of all the equipment manufacturers but every industrial engineer experiences such conditions very frequently and it is difficult to understand how they can be justified. A number of communications to the Forum telling of similar experiences will undoubtedly cause the manufacturers to give the subject more serious consideration. A single complaint here and there does not always register but when complaints appear collectively they are considered more seriously and that is one good reason for the existence of this Forum.

* * * *

WHY is it that the industrial engineer does not receive more recognition? This question is put to me occasionally and I always give two reasons. First, he is too efficient. Second, he does not know how to sell his ideas or himself.

As an engineer he acquires the habit or insuring a return for every expenditure of time, effort or money and as the habit grows he insists upon a quick return. Right there he becomes guilty of the very thing that he often accuses the management of possessing; that is of a short-sighted policy. He attends an engineering meeting or reads a technical magazine and because he does not immediately become possessed of some startling

Forum

new idea that will save thousands of dollars in his plant, he casts them aside as not giving a proper return on the time and money spent. He believes that he is more efficient because he is not wasting time and money when it doesn't bring immediate returns. Industrial engineering covers many branches of engineering; each succeeding weeks brings up a problem in power, heat transfer, civil, hydraulic, refrigerating, ventilating, materials handling or electrical engineering. How can one in this profession be ready at all times to improve, correct, lay out or design installations of such a wide variety unless he is conversant with the best practice. In order to meet the situation it is necessary to read widely and to support engineering societies not only for the technical papers and discussions but to widen his acquaintance with other engineers so that he may secure information that doesn't get into print. Surely it cannot be accomplished by shutting himself up in his own plant and not knowing what is going on outside. A manufacturing concern has to put some of its earnings back into the plant or it will go backward. An industrial engineer must put of his time and money back into his profession or he too will go back. You will get out of your profession just what you put into it.

* * * *

ALMOST invariably an engineer will devote all the time necessary to work out the solution of a problem, but entirely neglects to study the method by which it is to be presented to the management in the most convincing way. It is necessary to solve the problem but it is also essential to sell it to the management. The engineer must place himself in the position of the manager or owner and try to see the proposition from his point of view. Things that are perfectly logical to the engineer are only indicated but they should be thoroughly explained to those who have not the same technical background. I know of an engineer who sometimes reads his proposal to a layman to see if he can understand the content and be convinced. If the layman cannot understand it, the proposal is rewritten until he does understand it. The proposal is then submitted to the proper authorities. This engineer claims that this method has been very successful. Then again some engineers make a flat statement or guarantee of savings or performance. The manager is not convinced by a mere statement, he wants proof and he should be given it without asking for it. He wants to know upon what facts or performances the engineer has based his statement, not that he wishes to act as an expert reviewer, but to determine whether the engineer has gone deeply into the subject or is just basing his statement on generalties. Considerable thought should be given to the writing of the report in order that it may be clear and logical.

* * * *

NOT only has the engineer failed to sell his ideas but in a way he has failed to sell his accomplishments. When a new installation is completed and working satisfactorily, the engineer considers it finished. This is wrong. After a year's operation the savings of the new installation should be figured and presented to show that results were actually as predicted. Often times pictures taken before and after a department has been altered are appreciated by the management and you often see them framed on the office walls. Comparisons with results of operation in outside plants give the management better appreciation of the engineer. The management is human and likes to feel that its staff is accomplishing results. They like it not only from a financial point of view, but their pride is such that they like to talk about it to other business men outside of the plant. It is possible to go too far and be boastful but that is not necessary. A certain amount of red paint, consistent with good salesmanship is justifiable. It is well for the engineer to study salesmanship.

* * * *

AN editorial in a recent issue of an engineering magazine urged plant engineers to be more ethical and order repair parts from equipment manufacturers instead of making their own. The argument being that the inventor of a machine is just as much entitled to the replacement business as he is to the original sale. The contention has some merit but it is not all of the story.

In the first place many inventions are due to successive steps in the development of engineering and not to any great degree of genius. A change in quality of materials or in price of labor and materials makes automatic machinery profitable. A number of manufacturers see the opportunity to apply power and certain mechanical movements, which are not new, to a new field. They all rush to the patent office and the first one to arrive gets the patent. The development is due to changes in economic conditions rather than to exceptional genius. Any one of a thousand engineers could accomplish the same thing if the problem was presented to him and the genius of a Watt, a Stevens, an Edison or a Marconi is not essential.

To my mind there are many such inventions on the market and I do not believe that industry owes the holder of the patent a soft living or great wealth simply because he won the race to the patent office.

A patent gives the inventor the exclusive right to the production of the invention but it does not award him the exclusive supply of replacement parts nor does it free him from competition with other methods or types of equipment. This provides proper returns to the inventor as long as his method is more economical than other methods or hand labor and to a certain extent protects the public against a monopoly. If the patent granted the inventor the sole right to supply repair parts, the owner would be at the mercy of the inventor Under present conditions the inventor must sell his replacements at a price that makes it advantageous to the owner to buy such parts instead of making them. Apparently many holders of patent rights do not take this point of view.

* * * *

RECENTLY Bert Freeman met me at one of his plants to show me his automatic combustion control. He could not leave when I did so he had me taken to a nearby station in his auto. On entering the car I found two Stilson wrenches and a bag of golf clubs. He assures me that the wrenches are not used on the clubs to cure slicing. But the point I want to make is that those articles typified the man. He is on the job night and day yet can find time to relax and spend some time in enjoyment and healthful exercise. He is a good example for a great many engineers who claim to be so busy that they have no time for pleasure seeking. Too often the real reason is not the job but is lack of executive ability.

QUESTIONS *Asked and Answered* *By Readers*

[HERE IS A PLACE *where you can get some inside information when you get stuck. The only restriction is that you do a good turn to the other fellow when he asks a question that you can answer from your experience*]

Winding Data for Old Induction Motor

Can any reader give me the winding data for an old G.E., Type KQ, three-phase, 220-volt, 10-hp., 1,800 r.p.m. motor? There are 48 stator slots which are large enough to accommodate 40 No. 14 wires with insulation. The bore is 8 in.; the core is 4⅜ in. thick, and there is 1¼ in. of iron below the slot. The slots are 1¼ in. deep. I want to wind this motor to deliver 10 hp. at 1,800 r.p.m. 220 volts, three-phase, 60 cycles.

Cape Girardeau, Mo. L.W.

* * * *

Locating Short-Circuited Coils in A.C. Motors

I shall appreciate it very much if readers will describe what they consider to be the simplest and best method of testing and locating short-circuited coils in three-phase, squirrel-cage induction motors.

Cleveland, Ohio N.T.B.

* * * *

Raising Water by Gas Pressure

We are lifting cooling water for gas engines from a drilled well 300 ft. deep by means of natural gas. A gas pressure of about 130 lb. per sq.in. is required; when it drops below this point, as it sometimes does, the flow of water stops. After raising, the water is passed through a separator to remove the gas, which is then turned into the main. We have a cistern 10 ft. deep by 8 ft. square, in which the water level is kept at 4 ft. I should like to lift the cooling water from this cistern by gas pressure, as the total lift would not be over 15 ft., and a much lower gas pressure would be sufficient. However, I have not been able to raise the water in this way, and wish that readers who have had experience in this work would tell me how it can be done. We do not want to put in a power-driven pump if we can help it.

McArthur, Ohio C.V.B.

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Connecting Single-Phase Transformer to Three-Phase Supply

We have two 75-kw., 12,000/220/110-volt single-phase transformers of the same make. One of these is used to supply a lighting load and the other is held as a spare. Additions to our plant will make increased capacity necessary, and I wish that readers will show me how to connect these two transformers to our three-phase supply so that we can obtain 220 and 110 volts.

Vancouver, B. C., Canada A.M.

* * * *

Raising Hot Water with Centrifugal Pump

The following problem has caused considerable discussion in our plant and I should like to have the opinion of readers on it: Is it practicable to raise hot water with a centrifugal pump? The temperature of the water will be between 180 deg. F. and 200 deg. F. and the lift will be approximately 3½ ft. If it is practicable to pump hot water in this way, what precautions should be observed in installing the pump? Also, what are the troubles most likely to be encountered? Your advice will be greatly appreciated. H. L. W.

Jeannette, Pa.

ANSWERS *Received to Questions Asked*

Protecting Small Transformers From Shorts and Overloads

We use several small 110-volt transformers for operating our bell and annunciator circuits. These transformers frequently burn out, apparently from short circuits or overloads. If fuses are used to protect these transformers, should they be placed in the primary or secondary circuits? Is there any better way of protecting the transformers? It may be that readers can tell me of a more dependable method of supplying the necessary current. R. S. T.
Worcester, Mass.

ANSWERING R. S. T.'s question, it is considered good practice to fuse both the primary and the secondary sides of small transformers that are used for bell ringing circuits and the like. The primary fuses in such installations protect the supply circuit in case of trouble in the transformer itself, while standard renewable or non-renewable fuses in the secondary side protect the transformer from short circuits in the bell circuit.

There are small transformers being sold, which are not only capable of ringing three 3-in. bells simultaneously, but are designed to withstand successfully short circuits in the secondary circuit. J. F. MORGAN.
Chief Engineer,
Mercury Mills, Ltd.
Hamilton, Can.

IN REPLY to the question by R.S.T., it is best to locate fuses on the 110-volt side in every case. In addition to these fuses, if there are many devices to be operated on the lower voltage side, that is, making a number of separate circuits necessary in different directions, it is also advisable to place fuses on the lower voltage side in each separate circuit; by so doing making it possible to localize the trouble or isolate it in one particular circuit so that it can easily be cleared.

It is possible, if the exact load requirements of the device are known, to obtain from the transformer manufacturer a transformer with characteristics which are such that a short circuit on the low voltage side will not burn out the transformer; the 110-volt fuse will, of course, take care of an internal fault that develops in the transformer.

In general, however, the writer has found it best to fuse the separate circuits on the lower voltage side; as any circuit trouble is more readily located in this way. This method of obtaining current is quite dependable provided the alternating current source is dependable. In certain installations where an absolutely reliable source of current is required for signal or bell operation, I have operated devices from a small direct-current generator driven by an a.c. motor in conjunction with a storage battery. Under normal conditions the load is carried by the generator, the battery taking a low or trickle charge. In case of trouble on the a.c. side, the battery will furnish the current to signal devices, and an automatic device will disconnect the generator.

Similar systems are used where the devices can be operated by either alternating or direct current, in which case the transformer gives the normal service and a battery is switched on automatically when the a.c. supply fails. C. OTTO VON DANNENBERG.
Electrical Division,
General Engineering & Management Corp.,
New York, N. Y.

How Can These Bearings Be Made to Run Cool?

We have a motor-generator set that consists of a 25-kw. 125-volt, d.c. generator direct-connected to a 2,400-volt, three-phase, 1,800 r.p.m. induction motor. This set has three bearings of the ring-oiling type, the middle bearing being much larger than the end bearings. The latter bearings tend to run very hot, especially in hot weather, although the oil rings are functioning properly. The bearings never become so hot that the hand cannot be held on them for 20 to 25 seconds, but they are too hot for our peace of mind. The motor-generator set has been running almost continuously for four years, the oil being changed at intervals. The commutator and brushes are in good shape and the set is never fully loaded, running about three-quarters capacity. My opinion is that the proper oil is not being used in the bearings in hot weather, and I should like to know whether a mineral oil should be used exclusively. If so, what characteristics should it have. I shall also appreciate any other information regarding the best methods of making these bearings run cooler. H. C. M.
McGaheysville, Ga.

REPLYING to H. C. M., I would say that if after running this motor-generator set for four years the hand can be held on the bearing for only twenty seconds or so, it is operating close to the danger point. If any abnormal condition occurs, such as low oil, or grit in the bearing, it will very likely freeze.

To remedy the trouble I would first check the machine up mechanically, making sure that the shaft is resting evenly along the length of the bearing, that there is sufficient end play, no undue friction against the sides of the bearing, and that the oil grooves are large enough and cut so as to supply plenty of oil to all parts of the bearing. I would also make sure that there is a hole in the ends of the bearing leading to the oil well, so that the warm oil passing through the bearing can be drained away and replaced with cool oil, which will help to reduce the temperature.

In cases of unusual heating of bearings I have cut slots or grooves in the shaft inside of the bearing. These slots should be about $\frac{1}{8}$ in. wide and $\frac{1}{16}$ in. deep, and be cut parallel with the axis of the shaft. However, such slots must not be cut under the oil rings, as this will cause them to jump, and make the trouble worse. The edges of the slots must be smooth or slightly rounded, to avoid cutting the bearing.

Sometimes larger oil rings will help, by carrying more oil to the bearing.

Inasmuch as the offending bearing is between the motor and the generator, part of the trouble may be caused by the fact that it is subjected to the heat from both machines. If possible, I believe it would be advisable to replace the iron dust caps with caps made of wire screen. These will increase ventilation, and yet keep dirt out.

Lastly, make sure that the machine is running at the speed for which it was designed.

On the electrical side, check up the airgaps on both the a.c. and d.c. ends. All shunt field polepieces should have the same air gap, and the interpole polepieces should have the same gap. It will also be well to determine the voltage drop across the shunt fields, series fields and interpole fields, in order to make sure that there are no defective coils.

A good way to find out how and where heating of any sort comes from is to start the machine cold and carefully feel all parts until those that are heating fastest are located. In this way it is often possible to tell where the trouble lies.

Selection of a suitable lubricant may require some experimenting, but a good, medium grade of oil should give satisfactory results in a set of this size and speed. SAMUEL CARBAT.
Newark, N. J.

Relation Between Power Factor and the Coal Pile

In trying to improve the operating efficiency of our plant a question has come up regarding the effect of power factor. We generate our own power and use about 600,000 kw.-hr. annually. Our generating and distribution equipment is of ample capacity, although we are operating at a power factor of only 65 per cent. I understand the effects of low power factor on the distribution system, but should like to know just how it affects the coal pile. I wish some reader would explain this, as I want to determine whether it will pay us, from the standpoint of fuel economy, to raise our power factor to 90 per cent, or thereabouts. E. A. W.
Toronto, Can.

REGARDING the question by E. A. W., the economic loss resulting from low power factor is the increase in copper or RI^2 losses caused by the current which must be carried in excess of that required for an equal load at unity power factor.

The total losses will be equal to the losses at unity power factor times the reciprocal of the power factor squared. In this case, we will assume that the copper losses at unity power factor are 5 per cent. If the cost of energy is 2 cents, the copper loss at unity power factor would be one mill. Therefore,

at 65 per cent power factor the loss would be 2.366 mills. If the power factor were raised to 90 per cent the losses would then be 1.23 mills, or 1.136 mills less than at 65 per cent power factor. For each kilowatt-hour lost in the distribution system there would be a saving of 1.136 mills by raising the power factor from 65 to 90 per cent.

Assuming the annual losses to be 30,000 kw.-hr., the saving would amount to $34.08. In addition to these losses, there is the additional investment in electrical equipment required to handle the excess current which, of course, results in higher fixed charges. Interest on this investment must be added to the operating losses to determine the total loss due to low power factor.

If his generating and distribution systems are large enough as he states, to carry this excess current, I doubt very much whether the expenditure of money in corrective apparatus would prove an economical investment. It appears to me, without other details, that it is cheaper for him to carry the current until such time as additional loading demands greater generator or distribution capacity, at which time corrective apparatus can no doubt be used to advantage.

For the time being I would suggest that E. A. W. study carefully the load conditions of each motor in his plant, in view of the possibility that rearrangements which could be made with little expense might be helpful. The chances are that his present low power factor is due to a great extent to cases of overmotoring. Changing motors around so that they will operate at nearly full load will improve the power factor of a plant considerably, without much expense.

B. W. SCOTT.
Lawrence, Mass.

How Does Increase in Frequency Affect Core Iron?

I shall appreciate it if readers will give me the answers to the following questions: (1) What is the highest frequency in cycles per second at which commercial core iron can be worked? I am referring to the iron used in transformers and induction motors. (2) What is the highest practical frequency that an induction motor will operate on with reasonable losses? (3) Which loss increases the most rapidly as the frequency is increased?
Detroit, Mich. H. F. W.

TO H. F. W., the following comments may be of some help.

1. Core iron as used in transformers or induction motors has been worked as high as 200,000 cycles, and it is being used at high frequencies on radio and high-frequency testing equipments.

The grade of material used has an important bearing on the effects of high frequency, as impurities decrease the permeability and increase the core losses. In general, high temperatures reduce the permeability and cause aging, although the silicon steel used to-day is non-aging.

This all means that for high frequencies the core iron should be worked at lower densities, and thin material of the proper composition used. The laminations should be well insulated.

2. This question is tied in with question No. 3, but in general 60 to 180 cycles are used. The losses are kept as low as possible by careful design and consideration of the application.

3. Assuming that iron losses are referred to, the core losses consist of eddy current losses and hysteresis losses. The eddy current losses increase directly as the square of the frequency. At high frequencies, thin plates are used to reduce the skin effect to a minimum. The hysteresis losses increase directly with the frequency.

A. C. ROE.
Renewal Parts Engineering Dept., Westinghouse Electric and Mfg. Co., East Pittsburgh, Pa.

Selection of Pulleys and Belts

When selecting pulleys and belts, should serious consideration be given to the coefficient of friction between a particular type of pulley and a certain kind of belt? Also, when operating belts at a speed of 6,000 ft. per minute, will a special treatment or construction of the face of the pulley result in a greater coefficient of friction?
K. M. S.
Lowell. Mass.

REPLYING to K.M.S., consideration should be given to the coefficient of friction, as the lower this is the greater will be the width of the pulley and belt necessary to transmit a given amount of power. Steel pulleys have a higher coefficient of friction than cast-iron pulleys, and wooden pulleys higher than either; so the width of belt and pulley necessary will be larger with the former than with the latter. The coefficient of friction of a pulley can be increased by covering the face with leather. This method has frequently been adopted and given good satisfaction while the leather lasted. The facing lasts a long time, but it should be renewed as soon as it shows signs of wear; otherwise it may cause increased wear on the belt.

W. E. WARNER.
Brentford, England.

I BELIEVE that K.M.S. will not find much advantage in considering too seriously the coefficient of friction of a pulley. The belt, from the friction standpoint, is more important than the pulley. For example, when it is new, a wooden pulley has a higher coefficient of friction than when it becomes worn and smooth. When it is new its coefficient of friction is usually higher than that of a steel pulley; after a steel pulley has worn smooth it has a higher coefficient of friction than a wooden pulley.

The type of pulley is important, however. A leather-covered pulley will usually have a higher coefficient of friction throughout its life than an uncovered pulley, but in general I am opposed to using coverings of any kind because they wear the belt too rapidly. Belt creep cannot be eliminated regardless of the type of pulley, and therefore, the rougher the surface of the pulley the greater the wear on the belt. A smooth pulley face is best. I would as soon have a smooth cast-iron pulley as anything else, provided the speed is not too high and other conditions are right. For speeds above 5,000 ft. per min. steel pulleys or their equivalent should always be used.

It is not necessary to specify a different pulley face for a speed of 6,000 ft. per min. than for lower speeds. At any speed the pulley crown should not be too great. Crown is advisable, of course, but it should be within reason. If Barth's formula for pulley crowns is followed for all speeds there should not be any trouble.

Regarding the "special treatment" as mentioned by K.M.S. I do not know what is meant unless it is the hard, rock-like covering that is sometimes put on pulley faces to increase the coefficient of friction. I have had experience with it but do not advocate its use. It is not always put on smoothly and its effect is the same as using leather or canvas covering, if not worse.

W. F. SCHAPHORST.
Mechanical Engineer, Newark, N. J.

Compound Winding of D.C. Generators

We are desirous of learning the number of turns needed for a flat compound winding of a 125-volt d.c. generator and also a 250-volt generator. So will readers kindly furnish me with a formula, which is suitable for ordinary repair shop practice, for determining the desired number of turns.
W. H. K.
Chicago, Ill.

IN ANSWER to W. H. K.'s question, I do not believe there can be any very accurate formula for calculating the compounding of d.c. generators, although there is a method of test which is quite satisfactory. Although a magnetization curve is a nice check on the work and of value in determining the average magnetic saturation, there are many outside influences that must be taken into account. Probably the greatest influence not mentioned in most theoretical calculations is the variation in speed of the prime mover.

If you can regulate closely the speed of the source of power you can get very satisfactory results. Put an ammeter and an adjustable field rheostat in the field circuit, a voltmeter across the brushes of the machine, and make provision for putting an electrical load on the machine through a suitable ammeter, so that the full load may be calculated from the instrument readings. Bring the machine to its rated "no-load" speed, adjust the shunt field rheostat so that the brush voltage is what you wish it to be; then read the field amperes. Now connect an electrical load to the brushes until the full-load amperage has been reached with the speed at what you expect in actual operation, and with the shunt field rheostat adjusted until the terminal or brush voltage is the same as in the no-load test. This assumes flat compounding.

If you wish the machine to be over-compounded, adjust the field rheostat

until the terminal voltage is what you desire and the line amperage is sufficient to give the rated output in watts, which is the product of the line voltage and amperes. Now read the shunt field amperes. The increase in the field amperes multiplied by the shunt turns per field pole will give the ampere-turns required in each coil of the series field.

The series wire should have from 1,000 to 1,600 circ.mils cross-section for each ampere at the probable maximum continuous load. A small, well-ventilated machine may use smaller wire than one that is partly or fully enclosed.

Before making this test it is necessary that the brushes be set for minimum sparking at all loads. On large machines a magnetization curve may be necessary, and then the drop in speed at full load and cross-magnetization estimated so that fair results may be attained. In any calculations from the magnetization curve it is necessary to allow for the voltage drop through the armature, brushes, and series field, which may amount to 5 per cent in some cases. Some machines are purposely over-compounded and then a series shunt adjusted at the time of installation for the compounding desired with the proper engine driving it. Any flat-compounded machine will be over-compounded if run above the tested speed, or under-compounded if run below its tested speed. Due to changes in engine speeds and variations in the magnetic saturation used by different manufacturers, the series turns may vary 100 per cent.

If the machine has interpoles, the tendency for the armature current to oppose the field magnetism should be small, and a small air gap causes more demagnetization. A low saturation in the field poles and a short air gap mean a maximum of field distortion and armature demagnetizing action. In a three-wire machine the series field may be split, putting the positive line through the series coils of alternate poles and the negative line current through the series coils on the remaining poles. The method of calculation is not changed when this is done.

EARL R. WITZEL.
Research Department,
The Kohler Company,
Kohler, Wis.

IN REPLY to W. H. K.'s question, he must first compute the armature ampere-turns per pole. The armature ampere-turns per pole equal the total number of coils in the armature winding times the turns in each coil times the current in each armature circuit divided by the number of poles.

In figuring the current output of the armature, multiply the rated kilowatts by 1,000 and divide by the rated voltage. Divide this result by the number of circuits in the armature and it will give you the current in each circuit.

After finding the armature ampere-turns, compute the ampere-turns in the shunt-field winding. To do this we must have a multiplier; below is a table of multipliers for determining field ampere-turns per pole based on armature ampere-turns per pole.

Horse Power	Shunt-field	Series-field
1	1.00	.80
3	1.20	.78
5	1.20	.74
7½	1.25	.72
10	1.25	.68
15	1.27	.67
20	1.28	.65
30	1.29	.63
50	1.30	.60
75	1.31	.54
100	1.32	.47

After finding the desired multiplier, multiply the number of armature-turns by this multiplier and the result will be the shunt field ampere-turns. But we want the actual turns, not the ampere-turns, so we must compute the voltage on each shunt field coil. In designing the shunt field circuit, allow for about 20 per cent drop in voltage in the shunt-field rheostat; therefore the voltage across each shunt-field coil will be—(E times .8) $\div$ P, where E is the line voltage and P is the number of poles.

The next step is to compute the mean length of one turn of wire in the shunt field circuit, from the dimensions of the field poles, allowing for insulation.

Now multiply the shunt field ampere-turns times the mean length of one turn divided by the voltage on one shunt field coil. This will give the size of wire in circular mils. From the table below find the circular mils allowed per ampere on the generator and divide the size of wire in circular mils by this figure and the result will be the permissible current. Then the size of wire in circular mils divided by the permissible current will give the number of turns needed in the shunt field winding.

Next consider the series field winding. Calculate the ampere-turns per pole in the same manner as for the shunt field, using the multiplier under the series field column. Now divide the ampere-turns by the ampere rating of the generator. This will give the number of turns in the series-field winding.

To calculate the ampere-turns per interpole, if the generator is of the interpole type, use the following formula:

$AIT\ [1 + (3\ PGL \div DL_p]$, where

AIT is armature ampere-turns per pole.
P is number of main poles.
G is length of air gap under the interpoles.
L is length of armature core in inches.
L_p is length of the interpoles in inches parallel to the shaft.

The allowance in circular mils per ampere for series and shunt field coil windings is as follows:

H.P.	R.p.m.	Circular Mils per Ampere Series-field	Shunt-field
½	1,300	950	4,500
1	1,900	860	2,500
2	1,700	430	1,200
2	950	680	2,000
3	1,100	840	2,200
3	930	1,000	3,600
5	1,000	800	2,200
5	860	900	3,000
7½	1,350	650	1,200
7½	725	850	1,500
10	1,250	640	850
10	750	750	970
15	1,200	900	1,200
15	600	1,100	1,800
20	1,050	800	900
20	600	1,100	1,300
30	975	840	950
30	600	1,200	1,600
50	900	650	1,000
50	550	720	1,300
75	800	600	850
75	525	750	1,000
100	750	680	1,000

Elizabeth, La. N. H. MAILHOS.

Automatic Starting of Motors After Failure of Power

We have six pumps in our mine driven by three-phase, 60-cycle, 440-volt, squirrel-cage induction motors ranging in size from 3-, to 7.5-hp. rating. The current supply to these motors is frequently interrupted by trouble in the feeder lines to the mine; also slate-falls in the mine often break one of the three-phase wires leading to one of the motors. Will readers kindly tell me what methods to employ so as (1) to protect the motors from overloads and single-phasing, and (2) automatically start the motors upon restoration of power after failure?
Eckman, W. Va. D. C. W.

IN REPLY to the question of D. C. W., an installation similar to the ones we see around the quarries, to get the results asked for in the question, will consist of installing a circuit breaker at the most convenient place, as close as possible to the main feeders, on each individual pump circuit. This breaker could be a three-pole, 60-cycle, 440-volt Auto-U-Relite Junior, equipped with Dalite (direct acting time limit) feature.

The ampere rating of the circuit breaker will obviously depend on the size of the motor to be protected, and can easily be determined.

At some convenient place, preferably close to the motor, install an across-the-line push button operated induction motor starter. An E. C. & M. type ZO starting switch, push-button operated, oil-immersed, across-the-line squirrel cage induction motor starter may be used. This equipment will provide protection for overload and phase failure. The starter should be complete with push button for no-voltage release operation.

The overload adjustment of the circuit breaker should be set slightly heavier than that of the starter so that the starter will trip first in case of overload on motor, or phase failure, but should be set light enough to protect motor in case starter overload device should fail to function. The breaker is so constructed that it may be locked open, to prevent power being thrown on by some unauthorized party. This is an important feature in preventing injury to persons and serious damage to equipment.

The starter having remote control, the operating push button may be installed at the most convenient place for the operator. When the "start" button is pressed, the operating magnet coil is energized which in turn closes the switch and starts the motor. Upon failure of power, the switch opens; and if the start button is left depressed, upon the return of power, the switch will automatically close as when button was first pressed. Pressing the "stop" button opens the control circuit, de-energizing the operating coil and opening the switch.

By the use of float switches with the above equipment, the pumping may be done automatically, keeping the water between the desired levels, without the necessity of having an attendant, constantly on duty.

Chief Electrician, R. H. FINCH.
Blair Limestone Co.,
Martinsburg, W. Va.

AROUND THE WORKS

THIS SECTION *is especially devoted to short articles describing ideas and practical methods devised to meet particular operating conditions. The items may refer to mechanical details of installation, inspection, testing, wiring, repair, maintenance, replacement, and emergency or unusual installations of equipment tributary to production. Special attention is given to shop or bench tools and short cuts or improved methods of handling work brought into the repair shop. Contributions from our readers are always welcome.*

* * * *

Small Coils Wound in Lathe With Inexpensive Device

WHERE the upkeep of hundreds of small motors and other pieces of electrical apparatus is a part of the day's work, the winding of coils may occupy a good deal of time and the results may not be as satisfactory as could be wished. If equipment is devised to speed up the work, there is not only a decreased labor charge but, invariably, the appearance and the accuracy are upgraded also. This point may be well illustrated by a concrete example, taken from a shop in the mid-west.

Some coils for an old Crocker-Wheeler 2-hp. motor were wanted. It would not have been possible to wind them by hand because, they would not have been taut, evenly wound, regularly tied or of the proper number of turns. Inasmuch as the shop has quite a little of such work to do, as well as coil winding for experimental purposes, they made the device which is shown in the drawings for doing such jobs.

A round piece of steel *S* was cut from an automobile shaft at a place where an end about 3-in. long was made and where there was a flange at the other end. To this flange is screwed a wood block *F*—a block that may be replaced by others of varying size. This block is of flattened hexagonal shape for these particular coils.

There is a deep "rabbet" all around the face of the block on the side opposite the flange. It is on this part that the coils are wound. Two ¼-in. carriage bolts are set into the block from the back and they project far enough to carry a wood cap *C* and two thumb nuts. With the cap in place, a slot approximately ½-in. square is formed all around the periphery of the block, which may be wound full, if desired.

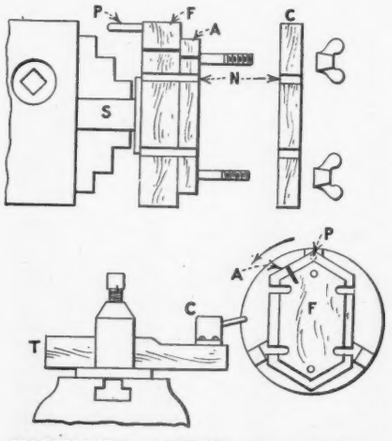
A slot *A* is cut through block *F* for holding the free end of the wire when starting. Four larger slots *N* are cut through both the block and its cap; these are for the tie wires which are put around the coils to bind them fast after the correct number of turns have been made. These slots are of a size that permits easy working, no matter if the ties are bands or wire.

After the ties are made, the cap is removed, the coil drawn off and another one is started.

One of the drawings shows the method of counting turns. Instead of doing the counting mentally, a counter *C* is used and the number of turns registered on the dials. A wooden bar *T* is clamped in the lathe tool post and the counter carried on its forward end. The arm of this counter points inwardly in such a position that it is struck by a pin *P* at every revolution. This pin is screwed in the wood block, out of the way of manual operations on the coils.

A counter is not an expensive device. Its use makes for more precise work which results in better balanced machine operation, as contrasted to that of a series of coils having uneven resistances. When a man is counting turns unaided, he is too apt to loose his count through the distractions of other shop work.

Such a coil winding outfit costs very little. It is really first class and, with the growth of block sizes, forms a valuable set for the repair shop. The time of setting up to wind is a mere trifle Put the stem in the universal chuck of the lathe and the counter bar in the tool post. Where a tensioning device is required, this is attached to some part of the lathe carriage, usually at the tool rest.



HOMEMADE DEVICE for winding small coils in a lathe. A front view is shown at the left. At the right, a view is shown toward the chuck with cover *C* removed.

Wrench Repair Department Saves Money

A LARGE factory in Connecticut has a department devoted solely to the repair of the wrenches used in the plant. This concern has found that it pays to look after tools of this kind just as it has a department which cares for belting and other equipment that comes under the supervision of the maintenance chief. Employees are not permitted to "fix" any tools, wrenches included. When a wrench gets out of order it is turned over to the foreman of the department who supplies a substitute. Foremen in production departments are supposed to look out for wrenches that get so worn that they injure bolt heads or might slip and skin fingers; the wrenches so collected are turned in and others which have been reconditioned are issued. This department does not make but repairs them; that is, they insert new parts, forge, grind or heat-treat only.

Most of the trouble with wrenches is due to wear, spreading or breakage. The foreman decides what is the best method of repair and whether the wrench is worth it or not. The broken wrenches are chiefly of the adjustable S-wrench type. The movable jaw gets broken more than any other part and a supply of these jaws in all the styles and sizes used is kept on hand. It takes only a few minutes to insert a new one.

Sometimes the pin inside the worm works out and one or both have been lost. Occasionally, one or the other of the jaws of such wrenches get broken off or a piece chips out. Whenever possible, the broken jaw is matched up with another when both are long enough for some use. The two jaws are then ground off even and the ends thinned. The tool is saved for work where a shorter jawed wrench will answer the purpose.

Monkey wrenches come in with "bent backs," broken handles and flaring jaws. The bent backs and flaring jaws almost invariably result from using a piece of pipe to lengthen the handle, jouncing on the handle (where a man can stand on the wrench) and when two men exert their strength on a small sized wrench. The backs are straightened either hot or cold and then heat-treated.

New wooden handles are applied or the handle is stripped of rivets and the wrench put into rough service. Sprung or worn jaws are ground parallel on all types of wrenches.

Forged wrenches make up the larger part of the repair work, because they

are used exclusively throughout the factory. Wherever a fixture does not have hand levers, it has case-hardened bolt heads that fit standard stock sizes of drop-forged wrenches. Open-end and socket wrenches, therefore, come into the department in large numbers.

Socket wrenches are reclaimed in two ways. The first is to grind off the end until a good workable surface of hex or square is presented at the end. The loss of $\frac{1}{8}$ in. in length will not spoil a socket wrench for any ordinary purposes. Often, when the spread runs back as much as $\frac{1}{4}$ in., the wrench can still be used after grinding if the center hole is drilled correspondingly deeper.

The socket is closed up on socket wrenches which must have their full depth of recess and are not worn so much that scrapping is the cheapest way out. Two heavy universal lathe chucks are mounted near a furnace and are used to squeeze these wrench heads together while hot. A piece of steel or mandril is first placed inside the socket to prevent squeezing too far. This mandril has its sides slightly concave in order to produce a shape that will not bind on the corners of the nuts or bolt heads when in use. Plain flat open-end wrenches are pressed together, either hot or cold and after heat treating, are ground out inside.

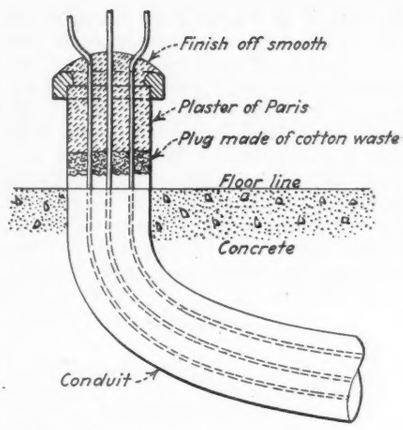
The cost of this department is kept low by putting the wrenches through in batches of similar kinds. A worth while saving results from the department. This work also saves in other maintenance expense through the elimination of ruined bolt heads and nuts. To quite an extent the idea could be advantageously followed in smaller plants.

DONALD A. HAMPSON.
Plant Superintendent,
Morgans & Wilcox Manufacturing Company,
Middletown, N. Y.

Keeping Foreign Objects Out of Conduit

SOME time ago the writer was sent to a plant to remodel he electrical installation. Much of the equipment was old but in fair condition. A number of feeders were brought to the switchboard in conduit which had been placed in the concrete floor when the building was erected, but instead of using a type *A* or *B* condulet at the end of each conduit run, only a bushing had been used. Due to the nature of the installation, it was not deemed advisable to replace the bushings with condulets, however, it was decided to close up the tops of the conduits to keep out foreign substances. This was done by ramming ordinary cotton waste around the wires, about 10 in. below the bushing, making this wad of waste about 4 in. thick. Plaster of Paris was then poured above the waste to the top of the conduit, finishing off the plaster as shown in the sketch. Two coats of black insulating varnish were then applied after the plaster had set.

If at any time it becomes necessary to withdraw the wires from the conduit, the plaster can easily be chipped out and the waste plug drawn out. In the meantime, however, the appearance of the plant is very much improved over the previous condition.



ONE WAY of treating conduit ends if the outlet fittings have not been used.

* * * *

CHAS. A. PETERSON.
Chief Electrician,
Fairbanks Exploration Company,
Fairbanks, Alaska.

How to Solder Rotor Clips Without an Iron

A FAST and reliable method of soldering clips on large size rotors does not require that a soldering iron be used.

The equipment needed for this method of soldering requires only some of the tools that are ordinarily found in a repair shop; namely, gasoline or electric blow pot, two ladles with which to pour solder over the clips and a trough of light sheet iron shaped as indicated in the accompanying illustration, with the edges turned up about $\frac{1}{2}$ in. high around the outside. By this method it is usually possible to get the bars hotter than with the use of a soldering iron.

THE METHOD shown facilitates the soldering of rotor clips.

Before starting secure the metal trough as shown and then prepare to solder one clip at a time for a good job. After using a flux preparation of rosin and alcohol, pour solder on the clip and also a little on top of it, and by so doing the bar is heated up and some of the solder will adhere. While the clip is still hot, fill in the space between the clips with wire solder, which were not filled when pouring the solder from the ladle. As soon as this is done, take a wiping cloth and wipe off the excess solder from the surface of the clip, and then the job is finished for that clip.

JOE F. WISINSKI.
Madrid, N. Mexico.

Pumping Unit Controlled by Interconnected Float Switch

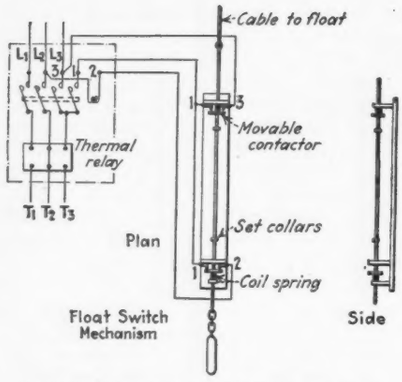
SOME time ago I ran across a novel scheme for controlling the water level in the supply tank of an industrial plant. The tank was supplied with water from a well, by means of a motor-driven centrifugal pump. An outdoor float switch was used for some time, but it failed to give service under the frequent starting duty. The controlling device was designed and constructed by Mr. B. D. Gammidge, Stockham Pipe & Fittings Company, Birmingham, Ala.

The device is simply and yet firmly constructed out of materials easily obtained around any plant shop. It is mounted indoors and has no inclosing case. A small case, however, for the live contacts located at the top and bottom of the mounting strip could be easily made if required. The base is made of a piece of wood, $\frac{7}{8}$x4x54 in. dressed on all sides and coated with black insulating varnish.

Four inches from the top was mounted the start contactor, which is normally held open, either by gravity or the combination of gravity and a coil spring. Eight inches from the bottom the lower or stop contactor is located. This contactor is closed when in normal position, and is of the disk type, with an insulating center of fiber. The disk or ring is $2\frac{1}{2}$ in. in diameter with a $2\frac{1}{4}$-in. hole in the center, and it is fastened to the $\frac{1}{8}$-in. fiber washer with four equally spaced countersunk rivets of suitable size.

The stationary contact points are made of $\frac{1}{16}$-in. copper, $\frac{1}{2}$-in. wide, 2 in. long with $\frac{1}{4}$ in. turned down, and drilled for two small bolts under which the wire is fastened. These stationary contacts are so mounted on fiber blocks that they make contact with the disk at the same time, which feature, minimizes arcing. A $\frac{3}{8}$-in. iron rod and a suitable weight, and a float will be all the material required for the control. The weight in this case was cast in the plant foundry and weighed about 7 lb.

For adjusting the level of the water in the tank two set collars are used. They may be located to maintain almost



CONSTRUCTION DETAILS and wiring diagram of float switch for controlling water level in a supply tank. The closing and opening of the contacts on the float device actuates the control of the motor driving the centrifugal pump.

* * * *

any water level between the top and the bottom. The weight serves to operate the stop contact and to balance the weight of the float should the tank at any time become empty, otherwise, the weight of the float might damage the start contactor.

This mechanism is used in connection with a G.E. magnetic switch, for across-the-line starting and it is equipped with a thermal relay for overload protection, however, the device could be used with almost any make of magnetic switch. The sketch shows a plan of the mechanism and also a wiring diagram of the connections.

The sequence of operation is as follows: At water level, the weight of the float closes contacts *1* and *3*, allowing current to flow through from *L3* to *L2* by way of the contacts *3,1,2* and magnetic contactor coil in switch, thereby starting the motor.

The circuit of the control magnet is closed to *1* in the switch, thus allowing the upper contactor on the float device to open without shutting down the motor. When the upper water level is reached the lower collar opens contacts *1* and *2*, thereby shutting down the motor. GRADY H. EMERSON.
Birmingham, Ala.

Method of Making Ladder Rungs from Gas Pipe

ONE OF THE accessories around the shop that should be in good condition at all times is a ladder, but, like other pieces of equipment, ladders are often permitted to deteriorate beyond the reclamation stage. Although wood is often desirable because of its light weight, wooden rungs soon wear out from constant use. More durable rungs may be made of gas pipe, without increasing the weight of the ladder very much.

The way to do this is to lay out the ladder uprights according to the desired length and spacing between the uprights. Cut pieces of 1-in. pipe just long enough to fit between the uprights. Then cut ¾-in. pipe long enough to extend beyond the outside of the uprights, allowing for the thickness of a washer on each side and enough material to rivet over the washer. For each rung drive a ¾-in. pipe through a 1-in. pipe until it extends an equal distance beyond on each side. Assemble the ladder parts and rivet the ¾-in. pipes cold over the washers. Additional washers may be placed on the inside of the uprights. A ladder that is built in this way is long-lived and is nearly as safe and strong as a steel ladder.

Effective Gravity Stop for Chain Conveyor

CONSIDERABLE trouble was experienced as well as extra work being necessary to get a coal conveyor untangled and back into service whenever the chain parted on the loaded side. Unless some means were provided to check the descent of the loaded side when the chain broke, buckets and chain would pile up in the pit. No trouble, however, was experienced on the empty side.

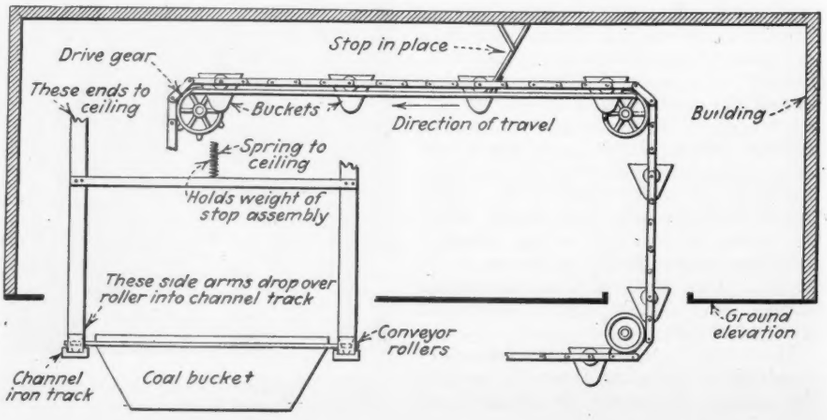
After several accidents of this kind we devised a "stop," and found that it worked satisfactorily because the next time the chain broke, it did not pile up at the bottom. It was caught at the first roller.

The scheme we used is shown in the accompanying illustration. The assembly consists of an iron frame suspended from the ceiling by hinges and a spring to sustain the weight of the stop. The lower ends of the stop were spaced so that they would fit into the channel iron track in which the conveyor rollers traveled. When the bucket passed the stop, the lower end swung out in the direction of bucket travel and when the bucket went beyond the end of the stop it swung back so that the ends rested in the trough. If the chain broke beyond this point it would only travel the distance between two buckets and come to rest instead of piling up in the pit below. Substantial ceiling anchorage will have to be provided or else the stop will be carried along with the chain thereby adding to the damage that would ordinarily be caused.

This stop can be used on almost any kind of a conveyor where the chain is apt to pile up in the pit, and it can be installed at very small expense.
Denver, Colo. R. M. THOMAS.

* * * *

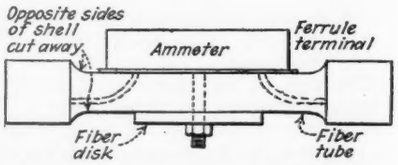
ASSEMBLY AND APPLICATION of gravity stop for chain conveyor installation. The upper view shows the application, of the device and in the lower left a side view shows the assembly.



Portable-Meter Connection for Light-load Testing

A CONVENIENT device, which necessitates the attaching of an ammeter to a cartridge type fuse, for readily testing the loads on small motors, is handy for service men that take care of many small motors.

To prepare a fuse for the portable ammeter, cut some of the fiber tubing away as indicated in the accompanying illustration. Then connect each meter terminal to one of the ferrule terminals by fuse wire that has a capacity slightly above the capacity of the meter. This fuse wire is for the purpose of protecting the meter as well as the motor in case of an overload or short circuit while making a test.



SKELETON VIEW of cartridge-type fuse showing how fiber is cut away to permit attaching leads to accommodate portable testing instrument.

* * * *

The dial of the meter is marked with a heavy line that is accompanied by a conspicuous number, which indicates the maximum amperage to be allowed for a certain size of motor. To protect the man doing the testing, the frame of the meter is taped.

By means of this device reliable testing results of the amperage load on small motors can be quickly checked with very little chance of an error in the reading even when these are being taken by electricians' helpers.

PRACTICAL BOOKS

for Your Personal Library

Every man who aspires to larger responsibilities should build up a professional library containing carefully selected volumes on subjects related to his work. Copies of the books which are reviewed here may be obtained from the publishers mentioned.

Financial and Business Forecasting

The Basic Business Cycle Theses Explained, and the Art of Forecasting Discussed Without the Use of Higher Mathematics.

By Dr. Warren F. Hickernell, Alexander Hamilton Institute, New York. 2 volumes, cloth, 5½x8½ in., 914 pages, $10 for both volumes.

TO THE business man and manufacturing executive who wishes to possess a working knowledge of the basic theories of the business cycle minus the all too familar perplexing mathematical formulas; a quick though vivid view of the waves of prosperity and of over-speculation, which have characterized the course of business in the United States and Europe for more than a century past; and finally the basic methods now in use in financial analysis and forecasting, this two-volume publication, by Doctor Hickernell, will prove most interesting and enlightening. The cyclic theories of Mills, Jevon, Moore, Juglar and Michell are explained in a simple manner, and their strength and weaknesses pointed out. Many business men believe that the business cycle, with all its attendant evils, is inevitable, just one of those things in life which have been ordained in the very nature of things, and for which there is no positive cure. While admitting that this belief has considerable foundation, based on the ups and downs of the past four centuries, yet the fact is made clear that there are cures for such cycles of wide variation in business and industrial activities, and a smoothing of the business cycle is even now being applied. History is very generously used to explain the basic reasons for these decided fluctuations of the past.

The scholar may stop with an analysis of the causes and effects, but for the man in active business the question of how to apply theory to his own affairs assumes paramount importance. Doctor Hickernell accordingly devotes his second volume to a study of financial analysis and forecasting, bringing out the fact that the four symbols of forecasting are: (*1*) Basic business statistics; (*2*) A knowledge of economic principles; (*3*) Perspective, based on a study of business history; (*4*) Good judgment in applying principles to the interpretation of statistics. It is necessary to study individual commodities, individual securities, and local business conditions, as well as the general trend of business. In this connection it may be pointed out that the use of mathematical methods in making charts of general business was of greater benefit before the World War than it is now under the regime of stabilized conditions, which has resulted from federal reserve control. Before the War industrial fluctuations went to extremes, and individual markets were importantly affected by the general trend. In recent years, however, economic conditions have been well stabilized, and the analysis of individual markets has become increasingly important.

Elements of Industrial Engineering

By George Hugh Shepard, Professor of Industrial Engineering and Management, Purdue University, Lafayette, Indiana. Published by Ginn and Company, 15 Ashburton Place, Boston, Mass. Cloth, 6x9 in., 541 pages, illustrated. Price, $4.80.

MANAGEMENT situations which the industrial engineer has to meet are infinite in number and variety, and he can deal with them by doing his own thinking on the basis of a thorough knowledge of the fundamental elements entering into them. This new book teaches no cut-and-dried system which the engineer can apply to any and all management problems. There is no such universal system. What Professor Shepard does is to reduce industrial engineering to thirteen definite and comprehensive principles* by which the engineer can analyze any problem and synthesize the procedure. The thirteen principles are fundamental and are, therefore, capable of general application. They are discussed clearly and at length, so that the student cannot fail to understand them and their use. Numerous illustrative cases drawn from modern industry show how the principles may be used to analyze management problems and how the results of this analysis may be used to determine the correct procedure.

The student is brought at once into working contact with the principles he is studying. Through the general discussion given in the text and through the problems which follow the chapters, the principles are applied to his daily life and to campus activities. In this way he uses the principles at once in a practical way, develops as opportunities for practice increase, his ability as a manager. Thus the student's interests and his everyday life are made a laboratory for the study and the application of the principles of management.

The methods of factory management taught in "Elements of Industrial Engineering" are thoroughly up-to-date and in accord with the latest practice. Sample forms are given where they are of assistance in the discussion of shop records. No untried theories are included. Every procedure that is recommended is based on practical experience in actual factories. The book presents reliable information in a way that is suitable for study by undergraduate students.

*Adaptation of Conditions and Work to each other, Correct Methods, Instruction, Fair Deal, Discipline, Planning and Despatching, Records, Standards, Efficiency Reward, Ideals, Personnel, Organization, Higher Common Sense.

Year Book 1928, American Engineering Standards Committee

Published by the American Engineering Standards Committee, 29 West Thirty-ninth St., New York City, N. Y. Paper binding, 87 pages, 7½x10½ in.

IN ITS Year Book the American Engineering Standards Committee not only reviews briefly the work that it has accomplished during the year 1928, but also explains its method of working and its use of available facilities.

There are listed in the book all the projects that on April 15, 1928, had an official status before the American Engineering Standards Committee, including standards that have already been approved and also those publications that are available. There is also listed co-operating organizations, members and sustaining members.

English for Engineers

By S. A. Harbarger, Assistant Professor of English, Ohio State University, Second Edition, 300 pages, 5x7½ in., $2.00. McGraw-Hill Book Company, Inc., 370 Seventh Ave., New York, N. Y. 1928.

A SECOND edition of this widely-known book on the practical value to the engineer of a good command of English. The book shows the reader how to get, through an intensive study of English, the power to present his technical ideas clearly and forcefully.

It presents the principles and methods of the major forms of technical writing and includes abundant suggestions for a systematic reading program.

NEW EQUIPMENT

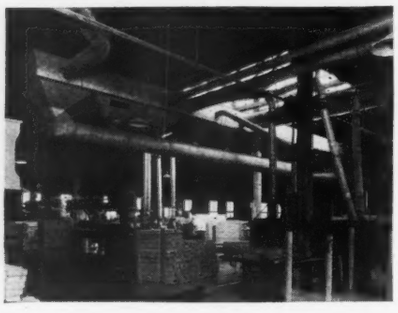
For Plant Operation and Maintenance

Industrial plant executives concerned with the selection and operation of mechanical and electrical equipment will be interested in these new devices which are designed to improve plant operation or reduce operating and maintenance costs.

Dust Collecting System

A NEW air-tight Plenum dust and shavings collecting system has been announced by The Kirk & Blum Manufacturing Company, Cincinnati, Ohio. This system, it is said, is particularly adapted to the wood-working departments of automobile body and other mass production plants.

This new air-tight system, the manufacturer states, permits of the removal of shavings piping from a machine and the reconnection of this piping to the main at a new location with no sacrifice of efficiency. The main duct is of one size throughout and connections may be made at any point from end to end with equally satisfactory results. The system contains no mechanical conveyor and no excess heated air wastefully handled by the fan. No shavings remain in the system overnight, which, it is said, reduces materially the fire hazard. No air enters this system other than that which enters with the shavings and refuse at the cutter heads of the machines.

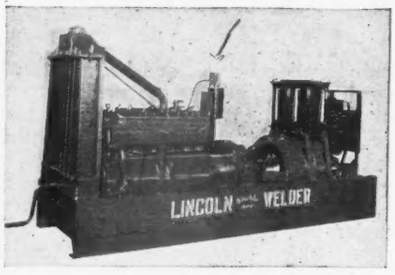


Kirk & Blum Chainless, Air-Tight Plenum System

Gasoline Engine Driven Welder

A NEW 300-amp. gasoline engine driven welder, known as model F-1964, has been announced by the Lincoln Electric Company, Cleveland, Ohio.

The welding generator is rated at 300 amp., in accordance with N.E.M.A. Standards, and has a current range of from 75 to 400 amp. for metallic electrode welding, and is direct-connected to a six-cylinder Buda model HS-6 engine operating at 1,500 r.p.m. Both units are mounted on a welded steel base, thus giving maximum strength and rigidity, with minimum weight, it is claimed.



Lincoln Electric Co. 300-amp. Gasoline Engine Driven Welder

The engine has an S.A.E. rating of 27.3 hp., and gives a brake-horsepower of 41 while running at the operating speed. It is said to be very economical in gasoline consumption. The gas tank is located in the channel iron frame under the engine, thus eliminating fire hazard.

The generator has the laminated magnetic circuit with separately excited fields, stabilizer, variable voltage and steel construction features characteristic of the company's line of "Stable-Arc Welders."

Combination Blower and Suction Device

SEVERAL new improvements in the Ideal hand portable blower have been announced by the Ideal Commutator Dresser Company, Sycamore, Ill.

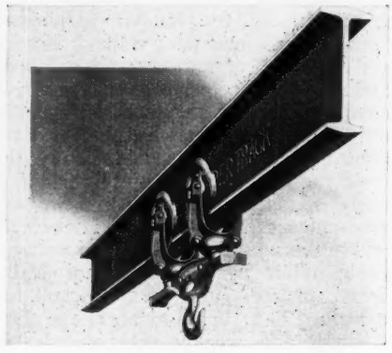
The blower is made in two models. The "Giant" and the "Super-Giant." The "Super-Giant" model is equipped with a full ½-hp. air-cooled Universal motor for voltages from 100 to 275. This motor, it is claimed, incorporates a new development in armature winding, which makes possible super power and greater durability.

It is also said that the new edition of the "Giant" model has the same high grade material and workmanship as supplied in the "Super-Giant" and has the same specifications except the motor, which is 205 watt and which can be supplied for from 32 to 275 volts. Both of these blowers can be changed instantly to a vacuum cleaner by the addition of a few extra parts. These attachments have been made for a great variety of purposes, including long tubes to reach high places, floor nozzles for office cleaning, special parts, and many others of a special nature.

Ideal Commutator Company Blower and Suction Device

Monorail System

A NEW heavy-duty monorail system known as the Louden Super-Track has been introduced by the Louden Machinery Company, Fairfield, Iowa. This track has a carrying capacity rated at 3,000 lb. which, it is claimed, allows a large margin of safety. This new overhead trolley track is a special section approximately 6 in. deep with a 3-in. flange at the top and a 2-in. flange at the bottom. Unlike ordinary I-beams, it is specially rolled, both as to form and material, for service as a trolley track. Special features also distinguish the new two-way, three-way, crosstrack and turntable switches designed for use with the Super-Track system.



The Louden Machinery Company Super-Track

The new track, it is claimed, not only handles heavier loads, but it eliminates, in a large measure, the necessity of supporting superstructure. Hangers, also, may be widely spaced, thereby saving time and minimizing the expense of erection. The company also states that the Louden Super track will not supersede the monorail system with the double bead track, but instead the Super track will be an addition to their line of conveying equipment which permits them to tap a broader market.

The track is available in straight lengths and curves, with switches, crossovers, and all the necessary fittings for any particular requirement.

Reversing Starter

A NEW automatic reversing starter for alternating current has recently been placed on the market by the Industrial Controller Company, Milwaukee, Wis. This device is rated at 15 amp. all voltages. It provides remote control, low voltage and overload protection, and is arranged for either two or three-wire control.

Overload protection is provided by the I-T time element thermal overload relays which are of the melting alloy type. The starter consists of two three-pole magnetic contactors mechanically interlocked.

The complete device is inclosed in a heavy gage sheet steel cabinet with a cover hinged at the side and provided with a latch for padlocking. The maximum ratings of this starter are single-phase, one horsepower, 110 volts; two horsepower, 220 volts; polyphase, two horsepower, 110 volts; five horsepower, 220-440-550 volts.

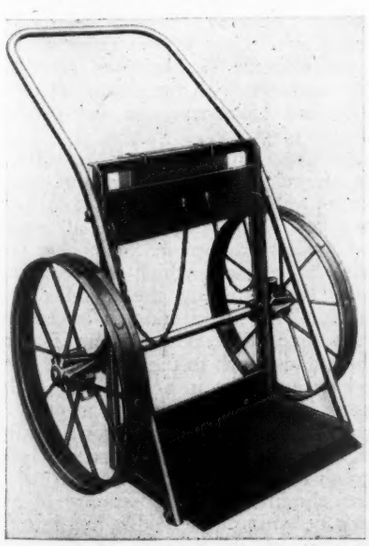
Large-Wheel Truck for Oxy-Acetylene Equipment

A NEW type of two-wheel truck has been put on the market by the Oxweld Acetylene Company, 30 E. 42nd. Street, New York, N. Y. Increase in wheel size was a primary consideration in the design, larger wheels making the truck much easier to handle.

The illustration shows the new truck equipped with 24-in. steel wheels, having 3 x $\frac{3}{8}$-in. grooved tires and a cast-iron hub. The hub is bored to fit the cold-rolled steel axle and a grease cup is provided for lubrication.

The handle is continuous and the upper portion is bent back about 8 in. so that the truck can be easily handled by an operator of small stature.

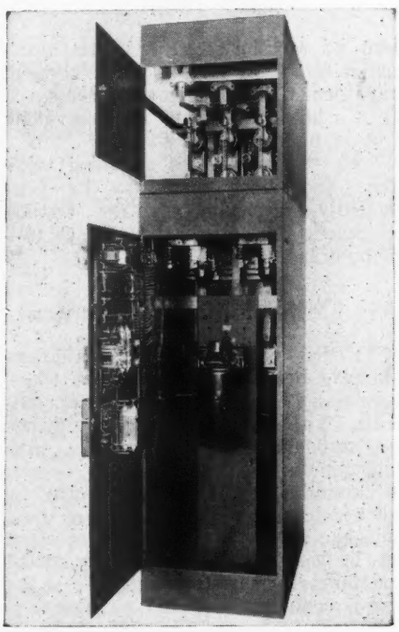
Where 24-in. wheels are not required, 14-in. wheels may be used instead merely by changing the position of the axle to the lower set of holes which are already drilled in the frame.



Oxweld Truck with 24-in. Wheels

Automatic-Reclosing Feeder Equipment

THE General Electric Company has announced a new line of automatic reclosing feeder equipment, mounted in completely inclosed cubicles. These contain a circuit breaker and disconnecting switches, and are operated automatically by relays mounted on the front panel.



General Electric Reclosing Feeder Cubicle

Heretofore the automatic-reclosing feature has been available only in the open type of equipment. The new cubicle construction has been designed to exclude dust and dirt from the operating parts, and insure safety of operation.

Circuit breakers and disconnecting switches are mounted on a channel frame which also supports the walls of the cubicle. The front panel is arranged in the form of a door. On the back of this panel is located all of the control wiring.

These cubicles are made in standard sizes and in ratings up to 7,500 volts. They may be arranged side by side to form a continuous switchboard.

Star Fuses

THE Star Fuse Company, 235 Canal St., New York, N. Y., have redesigned their line of renewable cartridge fuses to meet the requirements of the Underwriters' Laboratories, and same were tested and approved by the Underwriters.

The outstanding feature of the Star renewable fuses is the fact that they are simple in construction and from the smallest to the largest size can be assembled without the use of tools. Furthermore, the renewable element is enclosed in a fiber tube which collects all the molten material and sediment, thus leaving the inside of the case clean after each blowout. This method of construction also makes it impossible to place two refills in the same case.

The Star Fuse Company also claims that by means of this construction a pressure is formed in the refill which chokes the arc formed when a fuse blows on a short circuit.

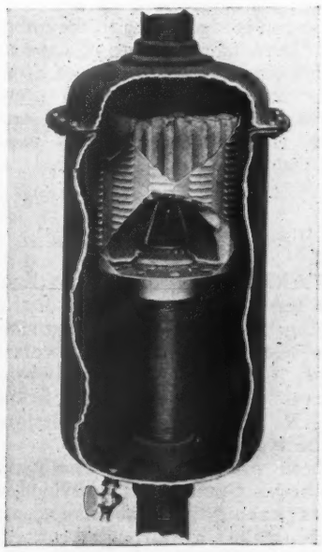
Air Filter

A NEW filter which can be easily inserted in the air lines has been placed upon the market by the Staynew Filter Corp., Rochester, N. Y. It is claimed that this air filter will remove dust, water, oil, rust, scale, and other foreign matter from air passing through pipes and prevent wear and damage caused thereby.

The filter consists of an aluminum housing inclosed in a pressed steel housing, which manufacturers claim will withstand a working pressure of 125 lb. The filter, mounted inside, consists of a self-filter medium formed in pockets over radial wire screen fins grouped about a central outlet. This permits mounting a relatively large area of felt in a compact base, and allows the use of the entire available area of felt with a negligible restriction.

As air enters the top of these filters, it is thrown against the inner wall of the steel housing by a shield over the top of the filter. The downward velocity carries water, oil, and most of the grit to the bottom of the shell. All remaining water, oil, dust, and grit is said to be caught by the filter. A drain cock is provided at the bottom to remove water, oil, and sediment in solution.

By closing a valve to shut off the air going into the filter housing, and opening the drain cock, the air in the outlet pipes or hose is blown back through the filter proper, removing all material on the filter surface.

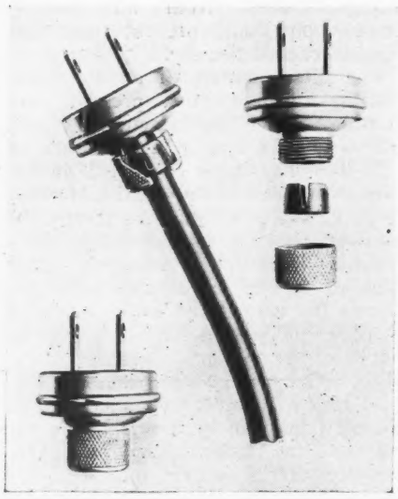


Staynew Filter Corporation Air Filter

Cord Grip Plug Cap

AN unbreakable attachment plug cap with an improved type of cord grip is announced by The Cutler-Hammer Mfg. Company, 199 12th Street, Milwaukee, Wis. The grip acts as a positive strain relief and is designed particularly to lessen short circuit hazards. Fastening the cord grip is an extremely simple matter and can be done without the use of tools, it is claimed. It is only necessary to screw down on the knurled collar.

The knurled collar wedges a fibre bushing tightly against the cord. The parts are so designed that a natural pressure from the inside prevents



Cutler-Hammer Cord Grip Plug Cap

loosening of the knurled collar and insures that a firm grip is maintained at all times.

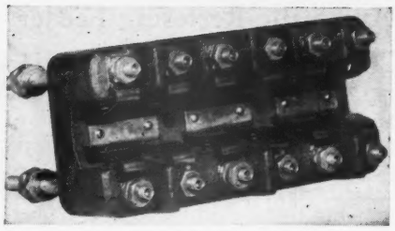
A fibre grip bushing serves to insulate the cord from metal parts and results in less damage to the cord because it prevents contact between cord and metal. This bushing also acts as the clamp and is the only part that actually touches the cord.

The cap is identical with the unbreakable "Dreadnaught" line of caps made by this company. A rustproof armored shell, made of heavy brass, prevents breakage when dropped on cement floors, etc. Sheet bakelite is used to hold the blades firmly in place.

Test Plugs and Blocks

MARKETING of a new line of test blocks and plugs, for simplifying the making of connections when testing meters, instruments and relays, has been announced by the General Electric Company, Schenectady, N. Y. They will be designated by the type number PK.

These blocks are essentially four-pole and six-pole jacks, provided with covers having internal plug contacts which make a through connection when the plug is in place. The blocks are provided with various combina-



General Electric Type PK Six-Pole Test Block

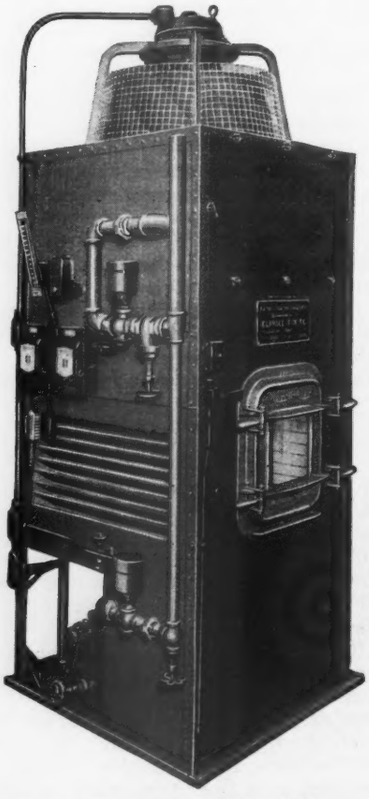
tions of auxiliary contacts that automatically short-circuit the current transformer when the cover is removed. Thus a block and cover are equivalent to a double-throw test switch.

Both test plugs are provided with studs and links, and may be permanently connected to the testing equipment for any of the various test methods in use.

Air Conditioning Equipment

TYPES B and I unit humidifiers have been announced by the Clarage Fan Company, of Kalamazoo, Mich. These are self-contained devices for automatically maintaining a predeterminated temperature and degree of humidity in a room, department, or other inclosed space. By means of these units the air in a compartment or room may be warmed and moistened, or cooled and dehumidified. In the latter case the unit is connected to a cold water supply.

The Type I humidifier, which is intended for general industrial application, does not require a system of sheet metal ducts; it discharges conditioned air



Clarage Type I Unit Humidifier

directly into the atmosphere by means of a positive, centrifugal-type fan, which it is claimed is designed with a self-limiting horsepower characteristic. This feature eliminates the possibility of overload on the driving motor.

Portable Light

DEVELOPMENT of a portable light, which is claimed to be watertight, vapor- and gas-proof, has been announced by the Motor City Electric Company, 316 West Jefferson St., Detroit, Mich.

The base of the light is made of heavy brass, provided with a substantial, hardwood handle. The lamp is protected by

Motor City Electric Portable Light

a glass globe that screws into the base, and is in turn protected by a heavy brass wire guard. The light is furnished with 25 ft. of Belden rubber-covered cord, and a Belden all-rubber plug.

Air Compressor Valves

AN improved air cushioned air compressor valve has been announced by the Pennsylvania Pump & Compressor Company, Easton, Pa. Chief among the claims of the manufacturer is the extreme simplicity of construction combined with the utmost of durability and efficiency, and the greatest element of safety.

An important feature of the valve is the air cushioned pocket in the guard. As the valve opens, instead of striking the guard, the disks enter this air pocket and the air trapped in the pocket provides a cushion which prevents the valve from striking the metal of the guard. This air cushion, it is claimed, is an exclusive Pennsylvania feature, which adds much to the life of the valve and its quietness in action. The valve assembly is held together by means of a retaining ring, which engages the valve guard and seat. There are no bolts, screws or nuts used in the construction, thus eliminating the possibility of any parts becoming loose and falling into the cylinder, to do damage to the compressor.

Super-Synchronous Motor Brake

AN AUTOMATIC brake, announced by the General Electric Company, Schenectady, N. Y. for use with its super-synchronous motors, eliminates the necessity for manual braking of the rotating stator. It is claimed that all the desirable features of hand braking are retained.

The brake mechanism consists of an upright standard that supports a vertical shaft, the lower part of which is threaded. When revolved it transmits motion through a trunnion block to a series of levers attached to the brake band. The driving motor for the brake is mounted on the side of the standard. A wheel is mounted on the end of the shaft so that hand operation may be employed.

When the brake is being released, the trunnion block travels upward, and is

General Electric Automatic Brake for Super-Synchronous Motors

stopped by the tripping of a limit switch when sufficient clearance has been obtained. In tightening the brake, the trunnion block moves down on the screw, automatically applying tension to the brake band until the action is stopped by a limit switch. By adjusting the weights on the brake lever, it is possible to vary the starting time of the motor from 5 to 40 seconds.

Grounding Wire Clamp

A RECENT announcement from the Copperweld Steel Company of Glassport, Pennsylvania, tells of the development of an extremely simple and effective grounding wire clamp. This clamp, listed as standard by Underwriters' Laboratories, is illustrated in the accompanying line drawing. It is designed to encircle the ground rod and securely bind the grounding wire directly to the driven member. With this method no solder or heat is required, it merely being necessary to pass the grounding wire into the clamp which has been placed around the driven rod, then tighten by means of a set screw actuated by a set-screw wrench. So securely does this simple little device clamp the wire to the driven member that, it is asserted, the wire is flattened against the rod thus increasing its contact surface and eliminating the possibility of slippage.

Copperweld Steel Company Grounding Wire Clamp

It is also claimed that not only does this simple clamp and wrench eliminate the usual bulky melting pot, ladle and other solder equipment, but that it reduces the time needed to effect the connection from an average of 30 minutes to about two minutes.

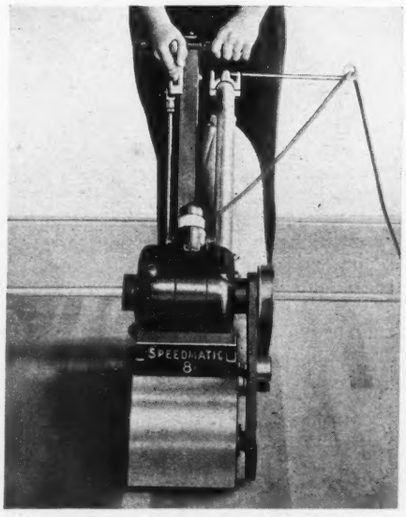
Floor Surfacer

A NEW floor sander, known as the Speedmatic Eight, has been marketed by the Porter-Cable Machine Company, Syracuse, N. Y. The machine, says the manufacturer, has been built along the lines of the larger heavy duty Type S-12, but in a much smaller size. One of the more important features of this new machine is the small drum, 8 in. in diameter. It is said that this is very useful in sanding wavy or uneven floors, as it is able to get into the low spots and smaller places.

The smooth action claimed for this machine is accomplished by means of shock absorbing or tension springs directly connected to the drum. As vibration causes chatter marks, much thought has been given to this particular part of the construction.

Despite the light weight, great pressure can be applied to the drum to insure intensive cutting. This is accomplished in two ways. The arms that support the drum are very long and are pivoted at the extreme end and not in the center. Thus, the weight of the drum is added to the pressure. The side tilt given to the machine throws the weight of the motor, the 16 lb. added weight, and the outside frame upon the drum through coil springs. The ordinary pressure is 45 lb. However, an extra 50-lb. pressure can be applied at the handle. Pressure to the drum is applied by a single, self-locking hand lever of toggle action principle. The machine sands within $\frac{5}{8}$ in. of the baseboard, which can be covered by the quarter round. It also sands within 3 in. in the front.

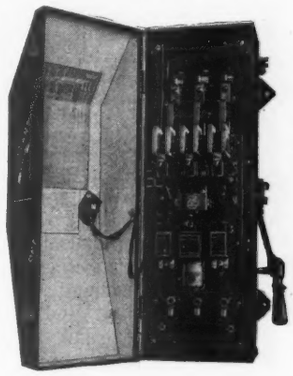
The machine is equipped with a 1-hp. G.E. motor, 60-cycle, single-phase or d.c., which is capable of a 50 per cent overload. A safety switch is conveniently located on the top of the motor. Ball bearings are used all around, sixteen in all, and are interchangeable, except those in the motor and drum. The machine can be operated from a floor plug with a 25-amp. fuse.



The Porter-Cable Machine Co. Floor Surfacer

Starter

A NEW Resisto-Transformer starter has been added to their line of motor starters by the Allen-Bradley Company, 286 Greenfield Ave., Milwaukee, Wis. The starter is a com-



Allen-Bradley Company Motor Starter

bination of the graphite compression resistor and the auto-transformer (compensator) type of starter, thereby obtaining stepless acceleration with low current input. Large squirrel-cage motors can be shunted without causing line voltage jolts, or dimming lights combined in the same network.

It is also said that no initial current inrush occurs because the compression resistors are connected in series with the auto-transformer when the motor is connected to the line. These resistors permit acceleration of the motor from standstill to full speed without opening the line connection to the motor. An auto-transformer reduces the line current in proportion to the transformer ratio. At full speed the motor is connected to the line without opening the line circuit, thus preventing the second current inrush. This starter contains the usual protective features.

TRADE LITERATURE

You Should Know About

Copies of literature which is described on this page can be obtained by writing to the manufacturer whose name and address are mentioned. It is always advisable to state the name and number of bulletin or catalog desired, as given in these columns.

BOILER BAFFLE—"Which Do You Prefer" is the title of a new bulletin which compares the Turner boiler baffle wall with the Beco baffle wall. Both of these baffles are built by the same company.—Boiler Engineering Company, 931 Federal Trust Building, Newark, N. J.

SWITCHES—Bulletin No. 10 is a complete manual on "Diamond H" remote control switches for loading circuits and other uses. A copy may be had upon request.—The Hart Manufacturing Company, Hartford, Conn.

GROUNDS—Bulletin No. 70 contains a complete treatment of the grounding methods used for power house, substation, and large industrial plant installations.—Borden Electric Company, 480 Broad Street, Newark, N. J.

ROCKBESTOS—A new folder recently issued describes some of the uses of Rockbestos switchboard wires and cables, and includes tables of sizes and capacities.—Rockbestos Products Corp., New Haven, Conn.

OVERHEAD SYSTEMS—Form TR-636 illustrates and describes some of the many uses of the Cleveland tramrail system in handling materials in the foundry.—Cleveland Electric Tramrail Division of the Cleveland Crane and Engineering Company, Wickliffe, Ohio

PLUMBING—Bulletin No. 178, entitled "Test on the Hydraulics and Pneumatics of House Plumbing," by Harold E. Babbitt, professor of sanitary engineering at the University of Illinois, has just been issued.—University of Illinois, Engineering Experiment Station, Urbana, Illinois.

TRANSFORMERS—Bulletin No. 628 describes a new line of air cooled transformers in sizes from ¼ to 50 kva. single-phase, two-phase, and three-phase. Sorgel Electric Company, 91 West 40th Street, Milwaukee, Wis.

UNIT HEATER—A recently issued folder describes in detail the Reznor Warm Air Gas Heater, Type 1-UR.—Reznor Manufacturing Company, Mercer, Pa.

OIL BURNERS—Heat When You Want It, Even Temperature, Safety, Quiet Operation and Economy are the five qualities listed as the prime requisite of the perfect oil heater in the latest booklet issued under the title "Are Oil Heaters Perfected?" The perfect heater, says the booklet, must be capable of supplying maximum heat when it is needed and of shutting itself off when the need has passed.—Oil Heating Institute, 420 Madison Avenue, New York.

SWITCHES—Booklet G.E.A.-942 contains specifications and drawings of the G.E. line of miscellaneous air-break switches, plugs and receptacles.—General Electric Company, Schenectady, N. Y.

BALL BEARINGS—"More and Better Production at Less Cost; what New Departure Bearings mean to machine tools," is the title of a new book recently issued.—The New Departure Manufacturing Company, Bristol, Conn.

PULVERIZED FUEL BURNER—Catalog U-3 describes and illustrates the Lopulco unit system for burning pulverized fuel. This catalog also contains illustrations and descriptive matter covering the various types of horizontal, vertical, and tangential burners used with this system, as well as a number of interesting application drawings.—Combustion Engineering Corporation, 200 Madison Ave., New York, N. Y.

LUBRICATION—"Lubrication for Safety and Economy" is the name of a new 20-page booklet recently published. It describes Houghton's Absorbed oils and the Gun-Fil lubricator. It explains in detail why the proper oil is essential to greatest economy in lubrication.—E. F. Houghton & Company, North Philadelphia, Pa.

UNIT HEATERS—Catalog No. 467 contains 27 pages devoted to recommendations for the application of Buffalo unit heaters. The book contains descriptions of a wide variety of installations and sizes.—Buffalo Forge Company, Buffalo, N. Y.

SAFETY—The June issue of the Safety Bulletin contains many interesting and helpful suggestions for the safeguarding of the man in the plant.—Bureau of Safety, Inc., 79 West Monroe St., Chicago, Ill.

ARC WELDING—Two entirely different types of arc welding equipment, the variable-voltage, single-operated type, and the constant potential, multiple operator types, are compared in the new Engineering Bulletin No. 206. The discussion covers the first cost of the equipment plus installation cost; the problem of interference between operators on multiple operator sets; economy of power of variable voltage equipments, curves being included to show graphically this power economy.—The Lincoln Electric Company, Coit Road and Kirby Avenue, Cleveland, Ohio.

SPEED CHANGER—A new folder describes the JFS variable speed transmission.—Stephens-Adamson Manufacturing Company, Aurora, Ill.

AIR CONDITIONER—A new booklet has been issued recently, containing a discussion on the control of humidity and temperature in bakeries and the part played by Bentz air conditioning equipment.—Bentz Engineering Corporation, 661 Frelinghuysen Ave., Newark, N. J.

UNDERCUTTER—A circular has been issued on the new Ideal mica undercutter, which it is claimed, can be operated without disturbing the brush rigging. — Ideal Commutator Dresser Company, Sycamore, Ill.

ELECTRICAL PRODUCTS — A catalog listing the complete line of electrical products made by this company is now available and may be had upon request. —The Chicago-Jefferson Fuse & Electric Company, 1500 Loflin St., Chicago, Ill.

PUMPS—Barton portable fire pumps for use on light cars and trucks are described and illustrated in Bulletin No. 60—American Steam Pump Company, Battle Creek, Mich.

SIGNALS—A new bulletin in colors, illustrating and describing Benjamin Industrial Signals, has now been issued. These signals are used for factory calls and signals, fire alarms, police call systems, traffic warnings, etc.—Benjamin Electric Manufacturing Company, 120 South Sangamon St., Chicago, Ill.

BEARINGS—The construction of the Wagner improved sleeve bearing and the Wagner double-cap ball bearing is fully described and illustrated in Bulletin No. 156—Wagner Electric Corp., 6400 Plymouth Ave., St. Louis, Mo.

DOORS—Catalog No. 110, "Truscon Copper Alloy Steel Doors," contains illustrations of the various types, together with specifications and drafting room standards, especially interesting to engineers and specification writers.—Truscon Steel Company, Youngstown, Ohio.

UNIT HEATERS—The 24-page catalog 127, entitled, "Heating with Thermodine," describes the construction, application and advantages claimed the use of the Thermodine unit heater in industrial plant heating.—Modine Mfg. Co., Racine, Wis.